EVALUATION OF RED CELL DISTRIBUTION WIDTH IN HEART FAILURE PATIENTS

Dissertation submitted in partial fulfillment of requirements for

M.D. DEGREE IN GENERAL MEDICINE

BRANCH I

of

THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY, CHENNAI, INDIA.

MADRAS MEDICAL COLLEGE,

CHENNAI 600003

APRIL 2013

CERTIFICATE

This is to certify that the dissertation entitled "**EVALUATION OF RED CELL DISTRIBUTION WIDTH IN HEART FAILURE PATIENTS"** is a bonafide work done by **Dr. BARANI VELAN.S.**, at Madras Medical College, Chennai in partial fulfillment of the university rules and regulations for award of M.D., Degree in General Medicine (Branch-I) under my guidance and supervision during the academic year 2010 -2013.

Prof.E.DHANDAPANI M.D.,
Professor of Medicine,
Guide & Research Supervisor,
Institute of Internal Medicine,
Madras Medical College &
Rajiv Gandhi Govt. General Hospital,
Chennai – 3.

Prof.N.RAGHU M.D.,
Director and Professor,
Institute of Internal Medicine,
Madras Medical College &
Rajiv Gandhi Govt. General Hospital,
Chennai – 3.

Prof.V.KANAGASABAI M.D.,
The Dean
Madras Medical College &
Rajiv Gandhi Govt. General Hospital,
Chennai – 3.

DECLARATION

I solemnly declare that this dissertation entitled "**EVALUATION OF RED CELL DISTRIBUTION WIDTH IN HEART FAILURE PATIENTS"** was done by me at Madras Medical College and Rajiv Gandhi Government General Hospital, during 2010-2013 under the guidance and supervision of **Prof.E.DHANDAPANI, M.D.** This dissertation is submitted to the Tamil Nadu Dr.M.G.R. Medical University towards the partial fulfillment of requirements for the award of M.D. Degree in General Medicine (Branch-I).

Place: Chennai-3
Date:

Signature of Candidate

ACKNOWLEDGEMENT

At the outset, I thank **Prof.V.KANAGASABAI M.D.,** Dean, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-3 for having permitted me to use hospital data for the study.

I am grateful to **Prof.N.RAGHU, M.D.,** Director and Professor, Institute of Internal Medicine, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-3.

I am indebted to **Prof.E.DHANDAPANI, M.D.,** Professor of Medicine, Institute of Internal Medicine, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-3 for his valuable guidance.

I am immensely thankful to **Prof.C.MARGARET, M.D., D.M.,** Professor of Hematology, Department of Hematology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-3 for her valuable guidance.

I would like to thank **Dr.K.THIRUMALVALAVAN,M.D., Dr.K.VIDHYA,M.D., Dr.A.SANTHI SELVI, M.D.,** Assistant Professors, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-3 for their scrutiny.

I would also like to thank all the professors and assistant professors of the Department of Cardiology, Department of Hematology and the Department of Biochemistry for their continuous support and expert guidance.

I express my sincere gratitude to all the patients who participated in the study.

Lastly, I thank all my professional colleagues for their support and valuable criticism.

TABLE OF CONTENTS

ABBREVIATIONS/ACRONYMS

ACC/AHA	American college of cardiology/American heart association
ANOVA	One-way Analysis of Variance
BNP	Brain Natriuretic Peptide
CAD	Coronary artery disease
CHF	Chronic heart failure
COPD	Chronic obstructive pulmonary disease
CV	Cardio vascular
DCM	Dilated cardiomyopathy
ECG	Electrocardiogram
ECHO	Echocardiogram
EDV	End diastolic volume
EF	Ejection fraction
ESC	European Society of Cardiology
GFR	Glomerular filtration rate
HDL	High density lipoprotein
HF	Heart failure
HFNEF	Heart failure with normal ejection fraction
HFREF	Heart failure with reduced ejection fraction
KG	Kilogram
LDL	Low density lipoprotein
LV	Left Ventricle
MI	Myocardial infarction

NO	Nitric oxide
NYHA	New York Heart Association
RAA	Renin-angiotensin-aldosterone
RDW	Red cell distribution width
RHD	Rheumatic heart disease
SV	Stroke volume
TNF	Tumour Necrosis Factor
UA	Unstable angina

INTRODUCTION

Heart Failure is a condition when there is acquired/inherited abnormality in the function and/or structure of heart leading to signs and symptoms that require frequent admissions and lead to decreased life span and poor quality of life[1]. Ischemia remains the chief etiology for heart failure worldwide. Heart failure is the final common outcome in all pathologies of heart disease. It is associated with a lot of comorbidities and lethality across the globe.

Over the last decade, several biomarkers have emerged in heart medicine like uric acid, neurohormones, hsCRP , BNP and many other pro inflammatory cytokines which help in the diagnosis as well as prognosis of heart failure.

Recently Red Cell Distribution Width (RDW) was found to be elevated in many heart failure cohorts. It is considered as a measure of variability in RBC size[2]. It is represented in 2 forms- RDW-CV (coefficient of variation) or RDW-SD (standard deviation). It is an easily available investigation as most of the hematology instruments measure RBC volume and give RDW. An elevated RDW can predict mortality and morbidity in heart failure. Various postulates and theories have been put

forth by many researchers for the cause for elevated RDW in the context of heart failure.

Januzzi and coworkers postulated from their research that RDW carries more prognostic information in addition to NT-pro BNP in acute heart failure. Few other studies also demonstrated that RDW is markedly elevated in severe heart failure independent of anemia and is a marker of worst prognosis. Hence RDW is clearly emerging as a new and promising biomarker in heart failure assessment, and candidacy for ventricular assist devices, IABPs, CRTs and transplantation.

Unfortunately there are not many studies comparing RDW with severity of cardiac failure. Here , I have planned to compare the parameter RDW in cases of cardiac failure and analyse RDW with severity of heart failure based on NYHA class and LV ejection fraction.

AIM OF THE STUDY

- To evaluate RDW in heart failure.
- To correlate RDW with severity of heart failure(NYHA functional class and LV ejection fraction).
- To correlate RDW with morbidity and mortality in follow up at the end of one month.

REVIEW OF LITERATURE

HISTORY OF HEART FAILURE:

MILESTONES

- 1628 William Harvey - circulation
- 1785 William Withering – cardiac glycosides
- 1920 Diuretics - introduced
- 1954 Imaging of heart- USG
- 1958 Thiazide diuretics
- 1967 Christiaan Barnard - 1st heart transplant
- 1987 CONSENSUS-I – use of ACE-I in heart failure
- 1995 ESC[3]- heart failure- guidelines for Rx

Accounts of heart failure antedates to ancient days. Understanding the natural history of heart failure has been phenomenal with significant evolutions from the day when Harvey described circulation. Inventions ranging from ECG, XRays, ECHO, cardiac catheterisation, newer biomarkers and nuclear medicine have succeeded in early diagnosis and effective treatment of heart failure patients around the globe.

Advances in heart failure therapy emerging from newer pharmacological agents to the use of surgical techniques, LV reconstruction, valvular surgeries, CRTs, ICDs, VADs and heart

transplantation have lead to the longevity of patients adding to the global burden of heart failure prevalence.

EPIDEMIOLOGY OF HEART FAILURE

Each year, new cases of congestive heart failure develop in about 550,000 patients. Nearly 1 million people get hospitalised for CHF yearly with 6.5 million hospital-days. Each year around 60,000 patients die of this condition.

Approximately one-third to one-half of the deaths in patients with CHF are secondary to the progression of cardiac insufficiency and its associated conditions. The remainder of the patients with CHF die of sudden cardiac death, presumably related to electrical instability and ventricular arrhythmias and other cardiovascular conditions as well as from noncardiovascular causes.

Data describing the natural history of CHF are limited due to lack of prospective studies[4]. The prevalence in in developed countries is 2.1%. Its prevalence increases with age, 10% suffering after they cross 65 years. It has a low incidence in women but 50% cases constitute females due to increased life span.

The Framingham heart study[5] showed that men in whom clinical symptoms of CHF developed had a 5 year mortality rate of 62%. Subsequent studies indicate that heart failure is a progressively

deteriorating condition, with 5 year mortality rate of 20–40% .Other studies show that patients with advanced CHF have 50% mortality.

Congestive heart failure is the inability of the heart to pump blood in par with the metabolic demands. It occurs either due to decreased myocardial contractility or an increased pressure or volume overload. Its haemodynamic consequences are diminished stroke volume (forward failure) and pooling back of blood (backward failure) alone or together.

DEFINITION:

A pathophysiologic state in which an abnormality of cardiac function is responsible for the failure of the heart to pump blood at a rate commensurate with the requirements of the metabolizing tissues.[1]

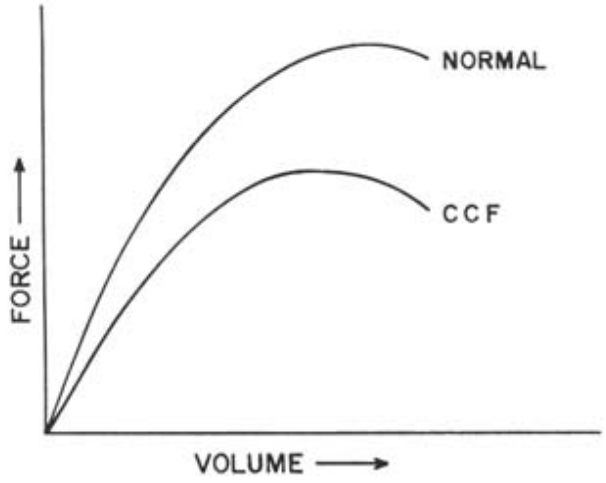
PHYSIOLOGY OF CARDIAC CONTRACTION

The force of contraction of the myocardium depends on

- preload
- afterload
- inotropic state (contractility)
- heart rate.

Preload:

According to the Frank-Starling law[6], increasing the resting length of the myocardial fibre can increase the force of isometric contraction. In an intact ventricle, the length of the fibre can be increased by increasing the end-diastolic wall tension (preload). This in turn is achieved by increasing the end-diastolic volume of the ventricle. The beneficial effect of increasing fibre length is however limited. Beyond the point of optimal stretch, increase in preload causes a decline in the force of isometric contraction.



Afterload is defined as the tension or force which develops in the ventricular wall after the onset of shortening (systole).

Contractility or *inotropic state* of the heart refers to a state of the heart muscle, affecting cardiac performance independent of the variations resulting from changes in the preload and afterload[7]. With constant

loading condition, increased cardiac contractility will augment cardiac performance.

Increased frequency of cardiac contraction increases contractility. Its effects in the intact heart are however limited and with rapid heart rates, contractility may actually decrease because of limitations of coronary blood flow and encroachment on the diastolic filling period.

TYPES

Cardiac failure may be classified as follows:

Acute versus chronic failure

- Acute heart failure develops after a massive myocardial infarction or valve rupture, whereas chronic heart failure is seen in slowly progressive valvular heart disease, dilated cardiomyopathy and systemic hypertension.
- In acute failure, sudden reduction in cardiac output leads to hypotension with no volume expansion, whereas in chronic heart failure there is no reduction of BP but there is oedema over the legs.

Left-sided versus right-sided failure

- In left ventricular failure, there is pulmonary congestion resulting in dyspnoea and orthopnoea.
- In right-sided failure, systemic congestion leads to raised jugular venous pressure, congestive hepatomegaly, and lower limb oedema.
- In long- standing valvular heart disease (aortic and mitral valve) and hypertension, combined features of left and right ventricular failure (congestive heart failure) are present.

High-output failure

High-output failure is present in

1. severe anaemia
2. hyperthyroidism
3. beriberi
4. arterio-venous fistula
5. Paget's disease

In most of these conditions, there is an increase in cardiac output to meet the oxygen requirement of the body.

Forward versus backward failure

- In backward heart failure the pressure and volume in the atrium and venous compartment are elevated, leading to retention of sodium and water and resulting in oedema.
- In forward heart failure, clinical features are explained on the basis of inadequate output due to reduced left ventricular systolic function, resulting in diminished renal perfusion, which activates the renin-angiotensin-aldosterone system with resulting salt and water retention and oedema[8].
- Both mechanisms operate in varying proportions in a majority of patients with heart failure.

Systolic versus diastolic failure

Patients with systolic heart failure have predominant systolic ventricular dysfunction, mainly due to myocardial dysfunction. The common causes are

primary heart muscle abnormalities

1. dilated cardiomyopathy
2. ischaemic heart disease

chronic excessive ventricular workload

1. systemic hypertension
2. valvular heart disease
3. congenital heart disease .

Disturbances of lusitropic function, i.e. failure of relaxation of ventricle, lead to elevation of ventricular diastolic pressure with normal ventricular diastolic volume. The commonest cause of failure of relaxation is ischaemic heart disease wherein reduction of myocardial perfusion results in diastolic dysfunction[9]. Failure of relaxation can also be caused by a stiff or thick ventricle as in restrictive cardiomyopathy secondary to infiltrative disorders like amyloidosis or haemochromatosis.

Lusitropic failure may be local or general. General diastolic dysfunction results in cardiac decompensation. Local failure results in failure of relaxation or dysdiastole, with non-synchronous coronary flow leading to myocardial ischaemia. Dysdiastole occurs early in

- hypertension,
- idiopathic hypertrophic subaortic stenosis (IHSS),
- cardiomyopathy,
- amyloidosis
- haemochromatosis
- constrictive or restrictive disease.

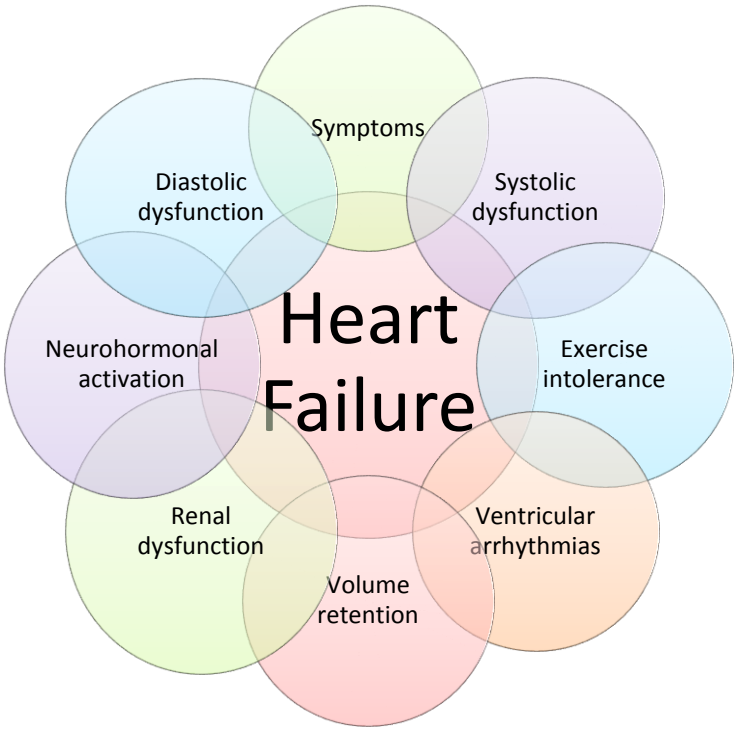
Systolic Heart Failure[10]	**Diastolic Heart Failure**
Large, dilated heart	Small LV cavity, concentric LV hypertrophy
Normal or low blood pressure	Systemic hypertension
Broad age group/ common in men	Elderly women more common
Low ejection fraction	Normal or increased ejection fraction
S_3 gallop	S_4 gallop
Systolic/ diastolic impairment by echo	Diastolic impairment by echo
Treatment well established	Treatment not well established
Poor prognosis	Prognosis is poor after hospitalization is required for heart failure
Role of myocardial ischemia important in selected cases	Myocardial ischemia common

Heart failure is now classified as

- heart failure with normal ejection fraction[6] 40%-50%
- heart failure with reduced ejection fraction <40%

SPECTRUM OF HEART FAILURE:

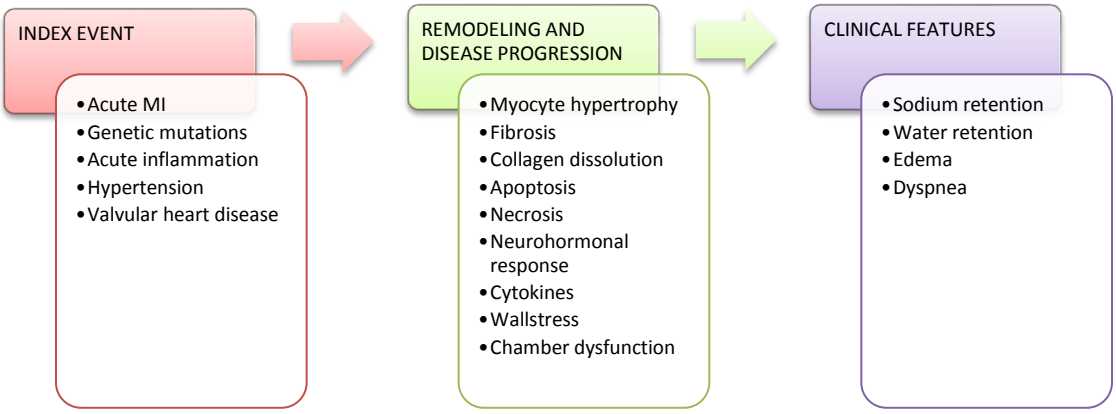
The syndrome of cardiac failure encompasses the following spectrum.



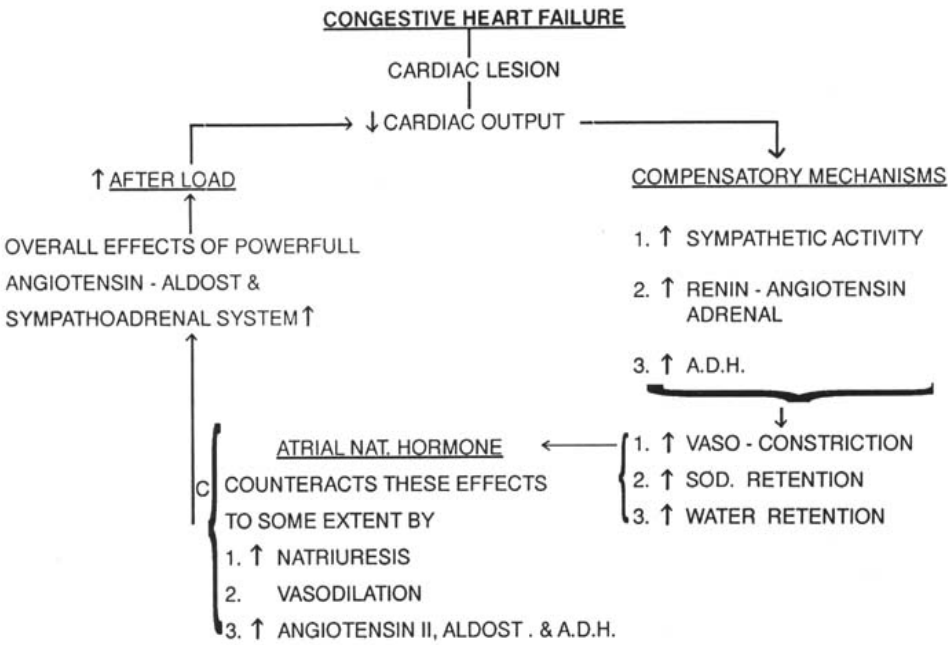
PATHOGENESIS OF HEART FAILURE:

Following any insult / injury[6], the myocardium responds by undergoing remodelling. Initially it preserves the cardiac output and eventually it proves to be maladaptive and results in clinical features of

cardiacfailure.



Increased peripheral vascular resistance compensates for the decreased cardiac output. But overcompensation can lead to an increased afterload which affects the ventricular function adversely, leading to worsening of heart failure. Thus a vicious cycle sets in



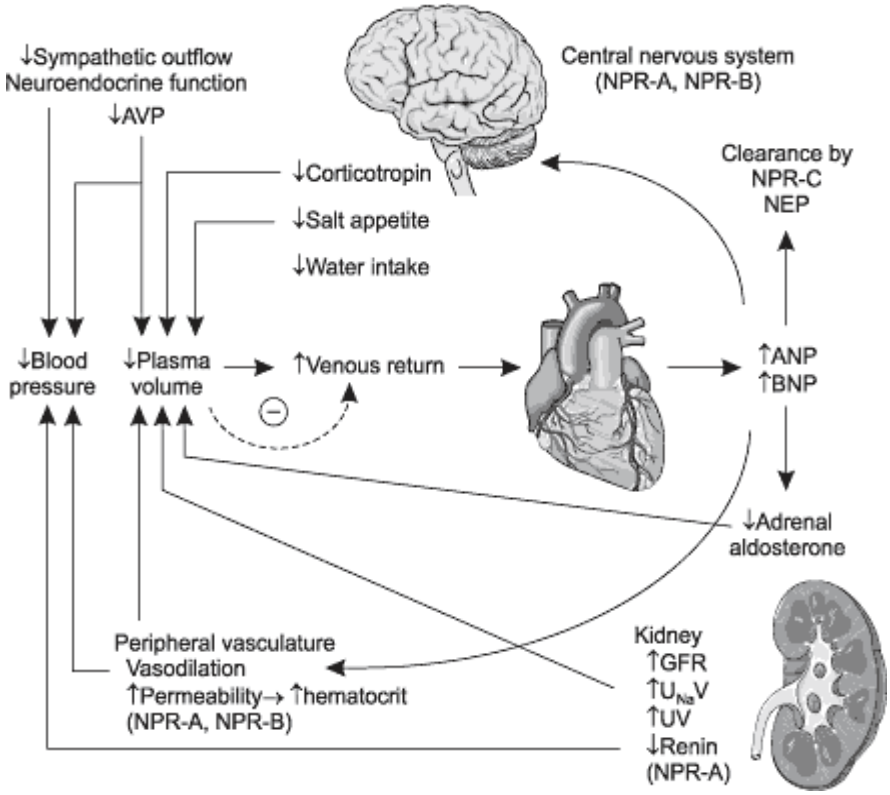
Possible Mechanisms of Myocardial Failure

- Loss of myocytes /Hypertrophy of remaining myocytes
- Inadequate O2 /energy supply
- Inadequate substrate utilization/energy storage
- Inadequate mitochondrial function [10]
- Ventricular remodeling
- Contractile protein abnormality/ defective synthesis
- Abnormal myofibrillar or myosin ATPase
- Activation of contractile elements --Membrane Na+,K+-ATPase defects
- Abnormal sarcoplasmic reticulum function --Abnormal Ca2+ release/uptake
- Abnormal myocardial receptor function
- Downregulation of adrenoreceptors
- Decreased Gs protein /Increased G1 protein
- Increased myocardial fibroblast growth and collagen synthesis
- Abnormal myocardial norepinephrine function or kinetics
- Abnormal baroreceptor function
- Aging changes/ presbycardia
- Sustained tachycardia

NEUROHORMONAL CHANGES IN HEART FAILURE[11]

1. Increased sympathetic nervous system activity (increased norepinephrine/ epinephrine)
2. Increased endothelin
3. Increased arginine vasopressin
4. Increased renin and angiotensin II
5. Increased aldosterone
6. Increased neuropeptide Y
7. Increased natriuretic peptides –ANP/BNP
8. Increased Insulin
9. Increased Cortisol
10. Increased GH
11. Decreased IGF
12. Increased TNF
13. Increased IL6
14. Increased VIP
15. Increased Adrenomedullin
16. Increased Urodilantin
17. Increased Urotensin-II
18. Increased Cardiotrophin-I
19. Increased dopamine
20. Increased PGI2/ PGE2

21.Increased vasodilator peptides (bradykinin)



SEQUENCE OF EVENTS IN HEMODYNAMIC ADAPTATIONS IN CARDIAC FAILURE[10]

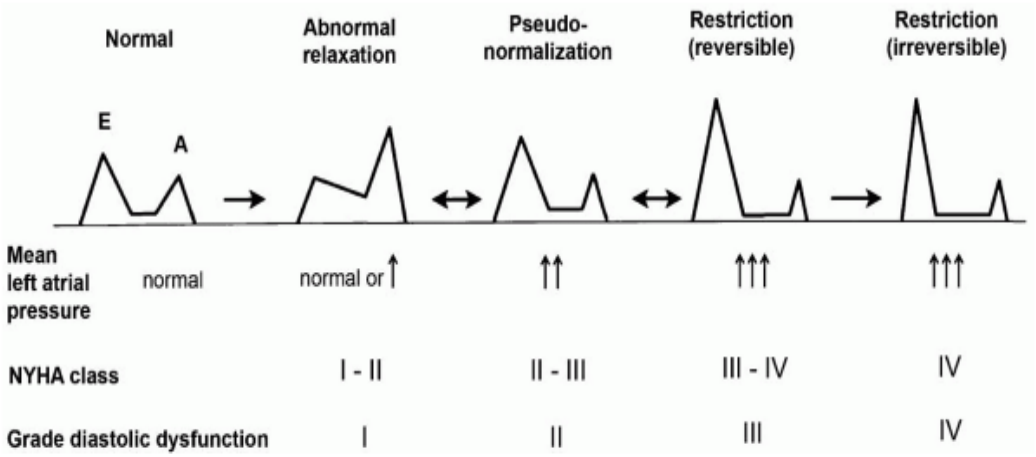
Increase in

1. LVEDV/LVEDP
2. Atrial volume/ pressure
3. Atrial /ventricular contractility (Starling law)
4. Volume and pressure in venous system
5. Capillary pressure / secondary transudation of fluid
6. Interstitial / extracellular fluid volume
7. Lymphatic flow from interstitial spaces

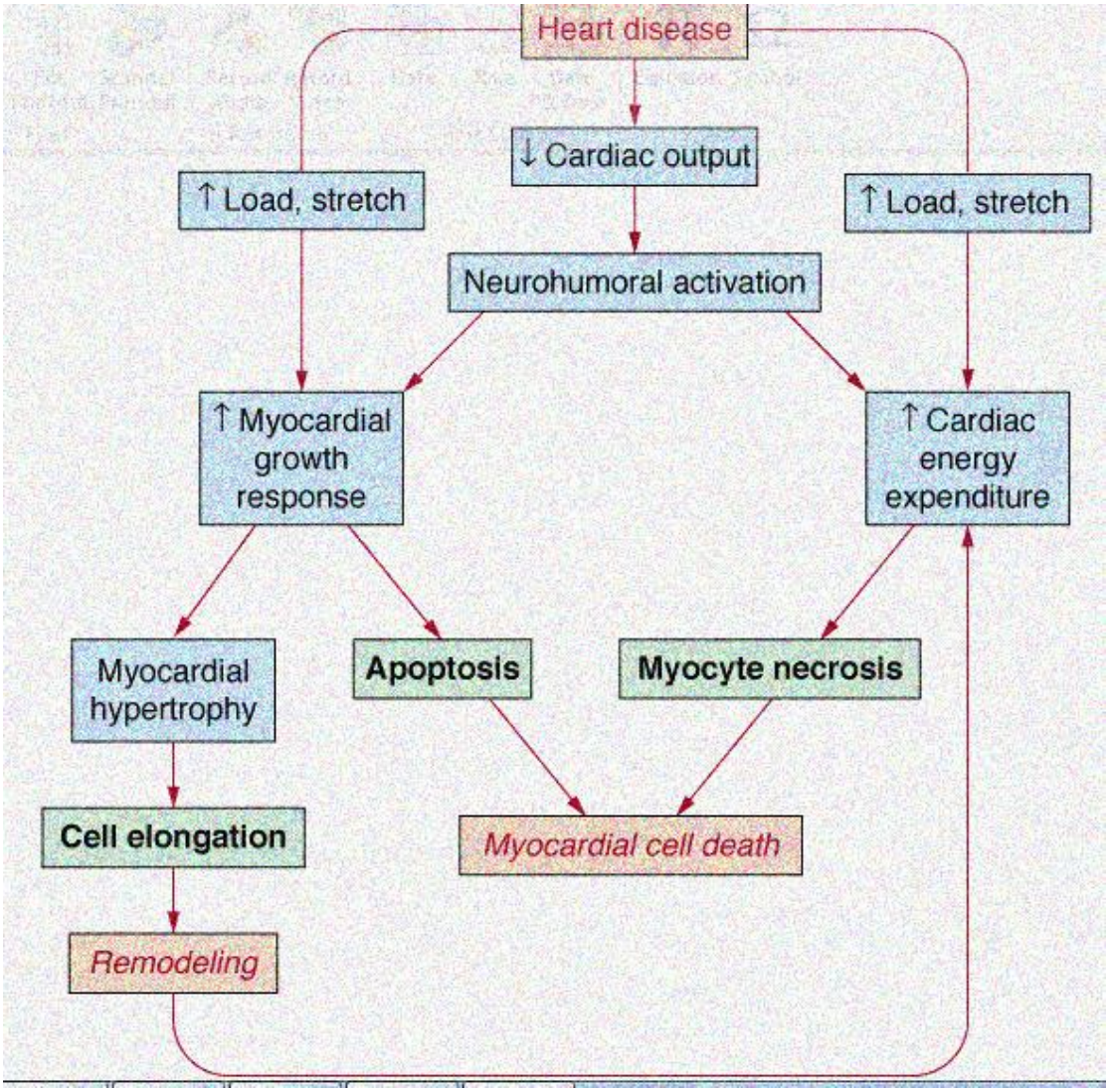
Factors Associated with Left Ventricular Diastolic Dysfunction.

- Hypertension
- CAD
- IHD
- Myocardial Scarring
- LVH
- DCM
- Myocardial fibrosis
- Constrictive pericarditis
- Infiltrative diseases

Stages of diastolic dysfunction[8]



With myocardial failure, ventricular dilatation can occur, maintaining stroke volume (the Starling effect). This dilatation can lead to failure of the mitral valves to close completely, resulting in mitral regurgitation. This then creates a secondary functional volume load for the already compromised LV. The schema of the sequence of events in heart failure is daunting. Distinguishing primary etiologic forces from secondary epiphenomena is difficult. Identification of the precise mechanisms whereby heart failure evolves and quantifying the contributions of individual components such as a primary decrease in capacity of myocytes to shorten adequately (eg, decreased contractility) or loss of myocytes (eg, apoptosis or myocardial necrosis) has remained elusive. Indeed, loss of myocytes with compensatory dilatation of the ventricle can lead to further loss of myocytes.



What triggers the early activation of the sympathetic nervous system and withdrawal of vagal tone and how spontaneous resolution of heart failure occurs remains unclear. Nevertheless, enough information has accrued to construct a reasonably coherent working hypothesis.

Molecular Adaptations and Maladaptations: Altered Cellular Proteins

The growth of genetics and molecular cardiology has provided important insights into the pathophysiology of heart failure . However,

because the cause and progression of heart failure is complex, both environment and genetics play important roles. Thus, there is no single cause or unifying mechanism of heart failure, and current therapeutic strategies target multiple pathophysiologic processes.

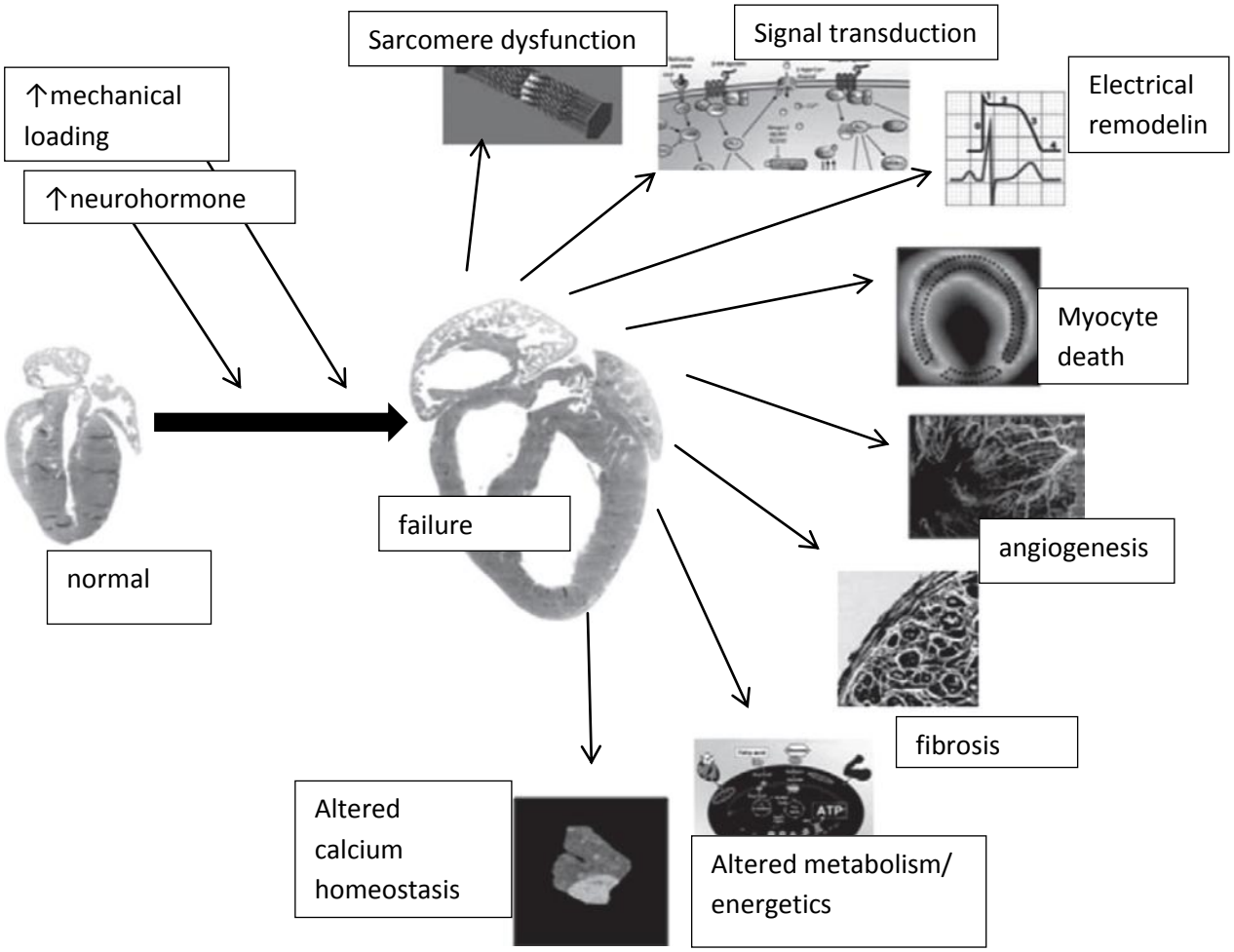
Alterations are found in the failing heart in numerous contractile proteins, especially in heredity-based idiopathic dilated cardiomyopathies. In the latter situation, these alterations can interact with abnormal loading conditions to cause heart failure. Such alterations have been found in the proteins of the cytoskeleton, myosin, troponin T, and actin and are likely to contribute to diminished myocardial performance. In animal models, various overloads can result in heart failure, whether from systolic loads (hypertension), loss of myocardium (infarction), inflammation, and so forth. Furthermore, in human failing hearts, the etiology can be modified from that in animal models. In the failing human heart, many changes in gene expression at the mRNA or protein level have been found in failing hearts harvested at the time of cardiac transplantation. However, these are often hearts with end-stage myocardial disease in which many factors (eg, receiving multiple inotropic drugs) can obscure the initial pathogenesis.

Sarcomeric Proteins

More than half of the volume of cardiac myocytes contains contractile proteins. Myosin comprises the thick filament that hydrolyzes

adenosine triphosphate (ATP), interacts with the thin actin filaments to produce force and shortening. Two myosin heavy-chain (MHC) isoforms are present in mammalian heart, α–MHC and β–MHC. The α–MHC is cardiac specific and is more enzymatically active. The less active β–MHC is present in the heart and in slow-twitch skeletal muscle. The distribution of α–MHC and β–MHC is developmentally and hormonally regulated. Mechanical stress, such as pressure overload, induces an α–MHC to β–MHC transition in the ventricles of experimental animals, thus imparting a slower but more economical type of work for the overloaded heart. Either way, myosin remains a principal structural and contractile unit of muscle fiber.

ALTERATIONS IN VENTRICULAR FUNCTION SYSTOLIC HEART FAILURE



There is a general agreement that myofibrillar function is depressed in the failing human heart, but its causal role remains controversial. Although such adaptive changes could be viewed to have an *economical* survival advantage in the face of increased load, slower contraction and relaxation could also contribute to diastolic dysfunction. In addition, isoform changes involving both the heavy and the light chains, as been suggested, can play a role in heart failure. In addition to myosin heavy-

and light-chain isoform switches, other well-understood pathologic events also contribute to altered cardiac function in various forms of heart failure. Point mutations of virtually all of the sarcomeric proteins cause hypertrophic cardiomyopathy . Similarly, mutations in the cytoskeletal proteins that provide the molecular scaffold for the sarcomere have been found in both dilated and hypertrophic cardiomyopathies. Echocardiographic studies have demonstrated that 20% of first-degree relatives of patients with idiopathic dilated cardiomyopathy have enlarged LV cavities.

Cell Membrane Ion Channels and Intracellular Calcium Kinetic Proteins

Plasma membrane ion channels initiate excitation–contraction by generating and then propagating the action potentials that depolarize the myocardium. These ion channels are complex and contain several subunits that surround the ion-selective pore. The intracellular calcium (Ca^{2+}) release channels are found in the sarcoplasmic reticulum (SR) and are quite different from those of the plasma membrane. The SR Ca^{2+} release channels are referred to as *ryanodine receptors* (RyRs) and interact with the ligand inositol triphosphate (IP_3). The Ca^{2+} pump ATPases are found in both the plasma membrane and SR. Both calcium pumps are activated by cytosolic Ca^{2+}. The heart's voltage-gated ion

channels (especially inward sodium channels) are altered in the failing heart,[7] as are outwardly rectifying potassium channels[12]. A common feature of animal models of heart failure and clinical heart failure in humans is prolongation of the action potential. Both decreased sodium influx and potassium efflux are contributory and are mediated by reduced activity of the sarcolemmal sodium and potassium channels, respectively. This aberrant channel behavior contributes to the arrhythmias, which are the second most common cause of death of patients with heart failure. Multiple additional mechanisms are also contributory, including excess sympathetic stimulation and extracellular matrix–induced scar formation.

Excitation–Contraction Coupling Proteins

The basic mechanism of cardiac excitation–contraction coupling involves calcium (Ca^{2+}) entry from the extracellular fluid by means of the voltage-dependent L-type calcium channel to produce a trigger in increasing $[Ca^{2+}]_i$ and opening of the intracellular SR Ca^{2+} release channel or RyR. Defects in sarcolemma Ca^{2+} uptake (sarcolemmal transport via Na^+,K^+-ATPase) and release by the SR are present in heart failure, especially at later stages,[13] but uptake of calcium by the SR can remain intact. These alterations in calcium transport can be secondary to quantitative alterations of gene expression of SR calcium transport proteins like SERCA and phospholamban, a reversible inhibitor of

cardiac SR Ca^{2+}-ATPase activity. Other calcium-cycling proteins such as Na^{+}-Ca^{2+} exchanger proteins[14] can also be altered in heart failure. Phosphokinase A hyperphosphorylation of RyR has recently been shown to alter calcium signaling from the SR by depleting calcium stores and reducing calcium transients that can impair contractility in the failing myocardium.[15]Several of these alterations can occur concurrently and can vary from model to model and may not always be relative to failing human hearts. Nevertheless, it is likely that heart failure is characterized by reduced myofilament activation and decreased calcium available for activation as well as heightened cytosolic calcium levels in diastole. Some studies have shown increased myofibrillar calcium sensitivity[16] and altered calcium kinetics. These abnormalities of calcium metabolism can be of primary importance in some types of heart failure, and they can be secondary or epiphenomena in other types. Most abnormalities of myocardial contractile activation have been demonstrated only in the late stages of heart failure and therefore can be the result of maladaptive hypertrophy rather than a primary cause of ventricular dysfunction.

Metabolic Maladaptations

Energy Production and Use

High energy phosphate levels are reduced in both animal models of heart failure[17] and failing human hearts.[18] Levels of phosphocreatine (PC)

are more depressed than ATP. Reduced PC levels impair the *shuttle* that normally transfers energy from the mitochondria to the cytosol. The abnormal pattern of energy production in the failing heart resembles that of the fetal heart. This is also true of abnormalities in excitation–contraction coupling, myocyte contraction, and myocyte relaxation. In essence, the failing (and fetal) heart is less reliant on the more efficient pathways of mitochondrial ATP production. Less high-energy phosphates are available to meet the increased work demands of the failing heart. Even a small reduction in the phosphorylation potential impairs ATP-dependent reactions because the heart has only a small phosphorylation *reserve* capacity. Moreover, decreased PC levels reflect more PC use rather than a lack of adequate PC.

Oxygen deprivation, which is most often caused by coronary artery disease, results in impaired relaxation and weakened contraction, as can be seen in transient angina pectoris. This is readily reversible. With prolonged ischemia, decreased contraction (dyskinesis) can persist for hours beyond return of blood flow (stunning). If coronary blood flow is chronically reduced, the myocardium can fail to contract normally (hibernation), even if necrosis does not ensue . With a more serious loss of flow, infarction can occur. All of these stages can produce substantial dyskinesia for which the remaining myocardium must sustain this load.

The result is hypertrophy of the nonischemic portion of the ventricle; if this is inadequate, an increase in ventricular volume occurs using the Frank-Starling mechanism to sustain SV. Whether there is a true limitation of energy supply or its use in the failing myocardium remains controversial.

In cardiac failure, the total oxygen requirement of the heart can be increased significantly because of the increased total mass, the increase in myocardial systolic wall tension because of the Laplace relationship, and perhaps some wasted contractile energy. This increase can result in the extraction of a greater amount of oxygen from each unit of coronary blood flow and a widening of the coronary arteriovenous oxygen difference. These patients are able to increase coronary blood flow during exercise; however, some patients with a dilated ventricle that increases in diameter during exercise can have a further widening of the coronary arteriovenous oxygen difference during exercise and a decrease in coronary blood flow reserve . Tachycardia, such as can occur with atrial fibrillation, can reduce diastolic time for coronary perfusion, producing ischemic ventricular failure.

Substrate Use and Energy Storage

Although the myocardial uptake of fatty acids and glucose per 100 g of myocardium is normal in heart failure, there is conflicting evidence

on whether or not there is a primary decrease in energy liberation by mitochondrial oxidative phosphorylation. The reductions in stores of myocardial high-energy phosphate, creatine phosphate, or ATP generally found in heart failure are thought to be secondary. This can be a consequence of the failure rather than the primary cause of the failure. There can also be reduced levels of creatine kinase and changes in the isoenzymes of creatine kinase in heart failure.

The major consequences of the state of energy starvation that is observed in failing hearts is not due to absolute reduction in ATP. It is the altered allosteric or regulatory effects of ATP which exert both inotropic and lusitropic effects .

Mitochondrial Mass and Function

Except when coronary flow is limited, such as with large vessel obstructive disease or purported microvascular obstructive or vasospastic disease, a primary role of energy limitation such as mitochondrial mass and function in the evolution of heart failure has yet to be demonstrated. It is possible that it plays a role during periods of higher metabolic demand, such as tachycardia, as noted previously.[19] Furthermore, mitochondrial dysfunction can produce increased reactive oxygen species (ROS) that can produce additional damage and death of myocytes.

Hibernation and Stunned Myocardium

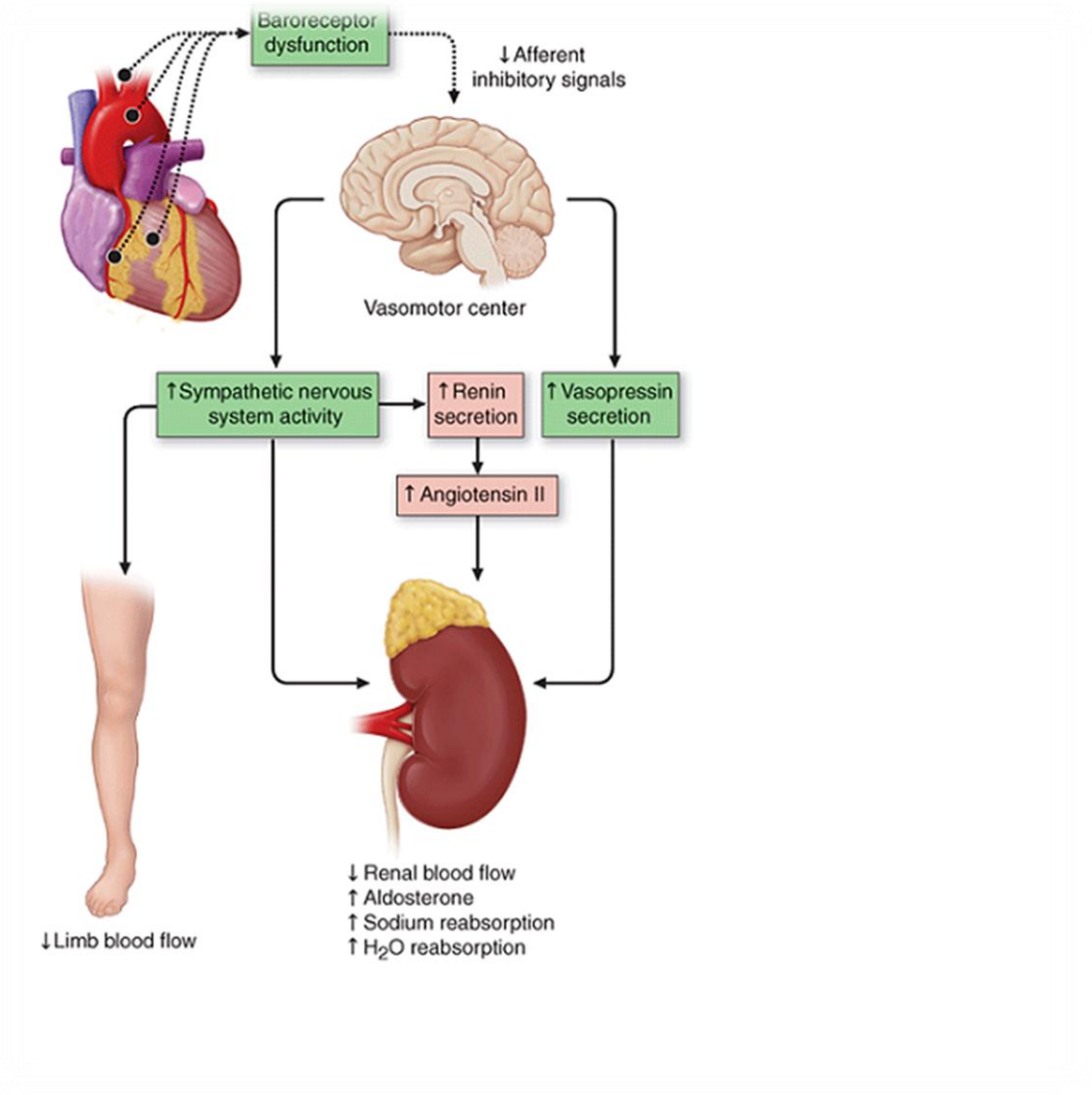
Systolic ventricular dysfunction as a result of focal loss of contraction can be dynamic and transient as can occur with acute ischemia. With restoration of metabolic requirements of an ischemic segment of myocardium, either from restoring adequate coronary flow or reducing oxygen requirements, myocardial contraction can be restored. Sometimes restoration is delayed, so-called *stunning*. Chronically reduced coronary flow can be inadequate to preserve contraction but adequate for myocardial survival. Such persistent depressed myocardium has been termed *hibernation* and with reperfusion can recover contractility over a period of time .

Physiologic Maladaptations

Autonomic Nervous System Dysfunction

An increase in systemic vascular resistance (SVR) is generally observed in well-established heart failure. It is likely caused by a combination of locally active heightened vasoconstrictors (norepinephrine [NE], angiotensin II, endothelin, vasopressin, neuropeptide Y) and by structural changes in blood vessels from fluid retention and reduced endothelial-dependent vasodilatation. These later changes are closely associated with limitations of exercise in heart

failure. Early in heart failure, there may be a decrease in cardiac output, arterial pressure, and baroreceptor activity, leading to an *adaptive* increase in excessive neuroendocrine drive.



The first adaptive change is activation of sympathetic nervous system, followed by the renin–angiotensin–aldosterone system (RAAS). ADH is released that leads to Sodium and water retention which maintains the cardiac output initially.However, as heart failure progresses, there is impaired cardiosensory activity that fails to reduce

neuroendocrine drive. For unclear reasons, cardiac afferent activity to the central nervous system is reduced, leading to unhindered, efferent excitatory responses from the brain to the periphery. Reflex vasoconstrictor responses to unload the heart are paradoxically blunted.[20] There are abnormal vascular responses to postural change. Some of these changes lead to alterations in regional blood flow that accompany heart failure. Parasympathetic (vagal) tone is decreased, and heart rate variability is markedly reduced, a hallmark of congestive failure. Furthermore, decreased heart rate variability can provide independent prognostic value in the identification of patients at risk for premature death.[21]

Although the genesis of these abnormal reflex control mechanisms is poorly understood, the changes can be more functional than structural. Heart transplantation reverses cardiopulmonary baroreflex control mechanisms to some extent, but this is inconsistent. The role played by abnormal reflex control mechanisms in the progression of heart failure, similar to other neuroendocrine alterations, has been difficult to quantify. Nevertheless, it is now increasingly clear that the sympathetic nervous system and the RAAS greatly influence the progression and natural history of heart failure with very important therapeutic implications.

Myocardial Receptor Dysfunction

The failing heart commonly demonstrates a decreased response to inotropic stimuli. Although no single mechanism accounts for this, the reduction in myocardial β–adrenergic receptors and the subsequent second messenger cyclic adenosine monophosphate (cAMP) can play an important role.[22] β–Adrenergic stimulation contributes importantly to the cardiac response to exercise, and β–adrenergic desensitization and uncoupling can be at least partially responsible for the reduced chronotropic and inotropic response to peak exercise commonly found in patients with heart failure. The β–adrenergic receptor abnormalities in heart failure appear to be caused by desensitization and uncoupling of the β_1 receptor produced by local rather than systemic alterations in catecholamines. In severe heart failure, the NE stores in sympathetic nerve endings are depleted. In a sense, the failing myocardium becomes functionally denervated. cAMP responses are reduced by approximately 30% to 35%, leading to further contractile dysfunction. Despite downregulation of the β_1 receptor, a relatively high proportion of β_2 receptors remains to mediate chronotropic and inotropic responses.[23] However, there is some uncoupling of the β_2 receptor from its G protein and a modest upregulation of the G_i subunit, further contributing to a depressed response to chronotropic and inotropic stimuli.[24] There is also a

profound decrease in cardiac β–adrenergic responsiveness with aging,[25] which has clinical implications because heart failure is heavily concentrated in the elderly population.

The desensitization and uncoupling of β –adrenergic receptors that occurs early with mild to moderate ventricular dysfunction is related to the degree of heart failure and is associated with a very reduced response to β–adrenergic stimulation with drugs such as dobutamine. Long-term stimulation of β–adrenergic receptors can enhance myocardial β–adrenergic receptor kinase activity,[26] leading to further desensitization and uncoupling of the β –adrenergic receptor.

Of great therapeutic interest, β–adrenergic blockade with metoprolol, a relatively cardioselective β_1-blocker, upregulates the β_1 receptor, but carvedilol, a nonselective β_1- and β_2-blocker with additional β_1 blocking activity, does not increase β_1 receptor density.[27] Both drugs improve LV function substantially in approximately two-thirds of patients. The ventricular improvement seen with chronic β-blocker use may not be caused by upregulation of β–adrenergic receptors, and the beneficial effects of β–adrenergic receptor blockade in heart failure remains unexplained. Moreover, high plasma NE levels do not predict benefit from carvedilol,[28] suggesting that there is not a simple relationship

between activation of the sympathetic nervous system and response to β – adrenergic blocking drugs in patients with heart failure.

Force–Frequency Response to Heart Failure

The failing human myocardium is characterized by an abnormal force–frequency response that parallels the severity of heart failure. Normally, an increase in the frequency of stimulation is accompanied by an increased rate of force development, a decreased duration of contraction, and an enhanced rate of relaxation (Bowditch effect). This tends to preserve or increase contractile force while preserving diastolic time. The latter effect is important in the tachycardic intact heart in preserving time in diastole to prevent ventricular filling and coronary blood flow. In isolated failing heart muscle, an increase in heart rate has been accompanied by a decrease in myocardial performance. Some impairment of systolic function in response to increased heart rate can also be related to impaired LV filling, although a negative inotropic effect as shown in isolated muscle has been related to alterations in intracellular Ca^{2+} handling. A reduced force of contraction and lack of shortening of contractile activity can contribute importantly to impairment of cardiac function during exercise.

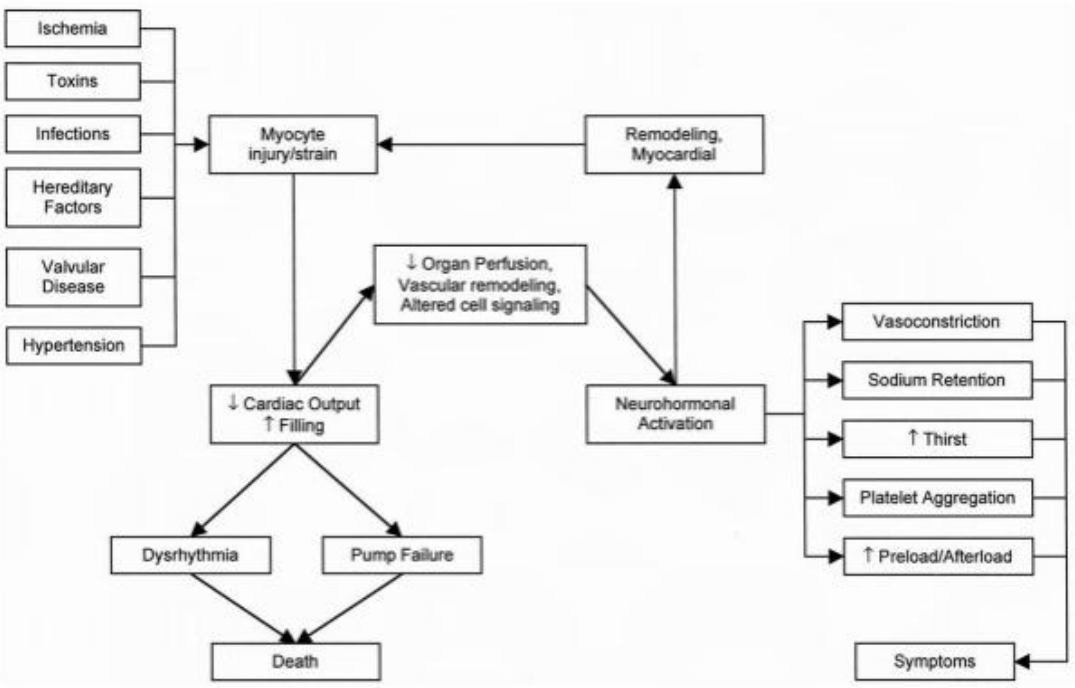
Hemodynamic maladaptations: The Hemodynamic Hypothesis

The term *heart failure* implies structural heart disease, and the central problem of heart failure remains impaired cardiac performance, although many of the secondary *adaptive* responses become maladaptive and contribute substantially to the progression of heart failure. In cardiac failure, the ventricular end-diastolic pressure (EDP) and the cardiac output can be normal at rest, but the former can become elevated to abnormal levels during stress such as exercise with increased cardiac output or an increase in afterload as the blood pressure increases. The ability to increase the cardiac output in response to the increase in oxygen consumption is also reduced. In severe systolic dysfunction, the EDP can be elevated even at rest. As the diastolic volume is increased, so is the end-systolic volume. This results in reduced elastic recoil of the ventricle during relaxation and is reflected in loss of rapid early diastolic ventricular filling (as revealed by a reduced E wave of the echocardiogram). This helps further increase the mean diastolic pressure. The elevated LV diastolic pressure increases pulmonary venous and capillary pressures and contributes to increased dyspnea as a result of changes in pulmonary compliance because of pulmonary congestion and edema. Before one reaches this stage of clinical heart failure, the body

has used many compensatory mechanisms, but compensatory mechanisms eventually have failed.

Summarising the pathophysiology of heart failure, five ideas are being considered:

1. The damaged heart can itself release cytokines, which activate systems elsewhere in the body.
2. The continued stimulation of the sympathetic system, possibly by neural pathways from receptors in skeletal muscle, can account in the long-term for cytokine activation.
3. Tissue hypoxia may contribute.
4. Imbalance of the autonomic nervous system modifies the function of the immune system.
5. Bacteria or endotoxins can gain access to the circulation and stimulate monocytes to generate cytokines.



Causes precipitating heart failure

- Cardiac arrhythmias
- Pulmonary embolism
- Infections, particularly lung infections
- Rheumatic or viral myocarditis
- Infective endocarditis
- Anaemia[2]
- Conditions with increased metabolic demand (pregnancy, thyrotoxicosis)
- Acute coronary insufficiency or myocardial infarction
- Accelerated hypertension

- Severe physical work or emotional excess increase cardiac workload
- Discontinuation of therapy (patient noncompliance or physician initiated)
- Other factors
    - Initiation of medications that worsen heart failure[10] (calcium antagonists, β-blockers, nonsteroidal anti-inflammatory drugs, antiarrhythmic agents)
    - Iatrogenic volume overload (transfusion, fluid administration)
    - Dietary indiscretion
    - Alcohol consumption
    - Exposure to high altitude

Stages of heart failure

Stage A: HIGH RISK - (SHT, DM, CAD, family h/o cardiomyopathy)

Stage B: ASYMPTOMATIC HF- heart disease without symptoms (previous MI, LVH, asymptomatic valvular disease)

Stage C: SYMPTOMATIC HF (NYHA classes II-IV)

Stage D: REFRACTORY ENDSTAGE HF- Patients with marked symptoms at rest despite maximum therapy who require repeated or prolonged hospitalizations/special cardiac support

New York Heart Association classification[29]

Class I: Symptoms only at levels of activity that would produce symptoms in normal individuals; ordinary physical activity does not cause undue dyspnea or fatigue

Class II: Symptoms on ordinary exertion, resulting in mild limitation of physical activity

Class III: Symptoms on less than ordinary exertion, resulting in marked limitation of physical activity

Class IV: Symptoms at rest or minimal exertion, resulting in inability to carry on any physical activity without discomfort

DIAGNOSIS

There is no gold standard diagnostic criteria for heart failure. Named criteria include

1. Boston criteria[30]
2. Duke criteria[31]
3. Killip[32] class (in the context of ACS)
4. Framingham criteria[5]

Framingham criteria (100% sensitive & 78% specific)

Diagnosis of cardiac failure needs

- 2 major criteria
- 1 major +2 minor criteria

Major criteria[5:]

- Cardiomegaly
- PND
- S3 gallop
- Basal rales
- Jugular vein distension
- Acute pulmonary edema

- Elevated Central venous pressure
- Positive abdominojugular reflux
- Treatment induced weight loss more than 4.5 kg

Minor criteria[5]:

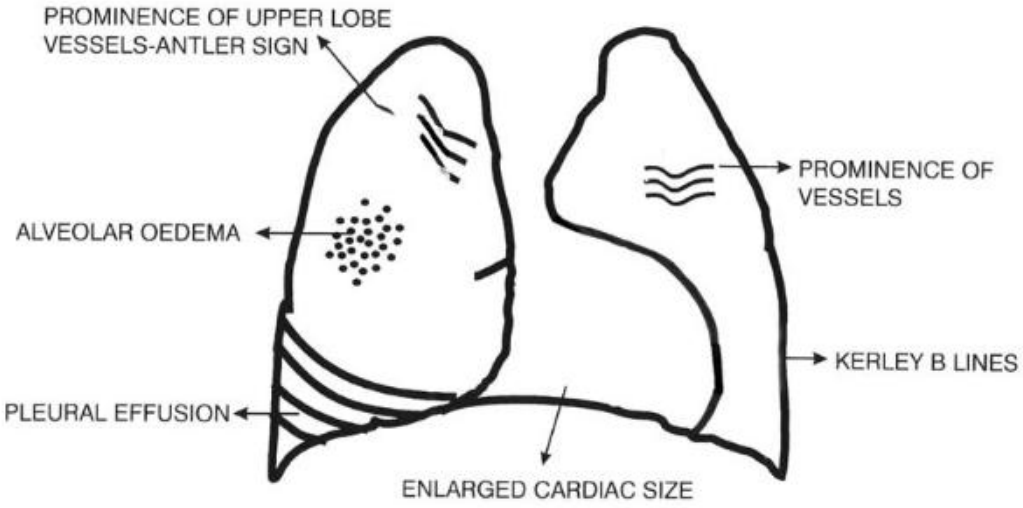
- Heart rate more than 120/min
- Nocturnal cough
- Shortness of breath
- Pleural effusion
- ↓ vital capacity (1/3 from maximum)
- Hepatomegaly
- Pedal edema

INVESTIGATIONS

XRAY CHEST

1. Pulmonary venous hypertension - dilatation and engorgement of the upper lobe pulmonary veins.
2. Generalised haze (due to interstitial oedema)
3. Kerley's B lines (due to prominent interlobular lymphatics) at the lung base

4. pleural effusion and interlobar thickening due to fluid collection.
5. dilated pulmonary artery
6. alveolar pulmonary oedema - butterfly appearance.
7. dilated superior vena cava and azygos veins systemic venous congestion.
8. cardiomegaly



Electrocardiography

1. LVH
2. LAE/RAE
3. BUNDLE BRANCH BLOCK
4. PATHOLOGICAL Q WAVES
5. AF
6. VENTRICULAR ARRHYTHMIA

Echocardiography/Doppler studies help in finding details about

- valvular lesions,
- hypertrophic subaortic stenosis,
- ruptured chordae of the mitral valve,
- valvular vegetations,
- left atrial myxoma,
- cardiac chamber dilatation
- pericardial effusion.
- ventricular ejection fraction[33]
- ventricular volumes.
- Regional wall motion abnormality

Radionuclide studies:

non-invasive and accurate measurement of wall motion abnormalities, ventricular volume and ejection fraction.

Cardiac catheterisation:

In CCF, there is increased end-diastolic ventricular pressure, reduced cardiac output with inadequate response to exercise, and reduced ventricular ejection fraction. Cardiac catheterisation is useful to determine the cause of heart failure and for grading the severity of the underlying heart disease

Laboratory investigations:

- A low serum sodium concentration indicates a stimulated renin-angiotensin system as well as increased vasopressin levels and is observed in patients requiring large doses of loop diuretics.
- A low serum potassium level and contraction alkalosis may also be observed in patients receiving diuretic therapy.
- An elevated blood urea nitrogen or serum creatinine level suggests either organic or functional renal impairment, caused by vasoconstriction, and decreased cardiac output.
- Liver-function abnormalities may suggest hepatic congestion.
- Thyroid-stimulating hormone should be measured at the initial evaluation, because both hypothyroidism and hyperthyroidism can be a primary contributor to the cause of heart failure.
- Measurement of creatine phosphokinase and isoenzymes, as well as troponin I or troponin T may indicate the presence of active inflammation or ischemic injury to the heart.
- Screening for human immunodeficiency virus is recommended for patients with high-risk exposures or a history of sexually transmitted diseases, with manifestations of infection with the virus such as lymphopenia, anemia, cachexia, or history of opportunistic infections.

GENERAL THERAPEUTIC APPROACH TO CHRONIC HEART FAILURE

Determine the etiology

Look for precipitating factors and correct them

Nonpharmacologic treatment

Sodium restriction (< 2 g/d)

Aerobic exercise

Weight loss in obese patients

Treat hypertension and other comorbidities vigorously

Pharmacologic treatment

Angiotensin-converting enzyme inhibitors (ACEIs)

Angiotensin receptor blockers (ARBs)

Aldosterone antagonists

beta-Blockers

Vasodilators (long-acting nitrates and hydralazine)

Diuretics

Digoxin

Device therapies

Cardiac resynchronization therapy (CRT)

Implantable cardioverter defibrillators (ICDs)

Left ventricular assist devices (LVADs)

RISK STRATIFICATION IN HEART FAILURE

The following parameters[50] are strongly associated with increased mortality in chronic heart failure and are recommended in risk stratification.

- Advanced age
- Low serum sodium
- VO_2 max (mL/kg per min <10–14)
- Low LV ejection fraction[33]
- Resuscitated sudden arrest
- NYHA functional Class III–IV
- Persistent low BP
- High serum BNP[34,35]
- Increased left ventricular volumes
- High serum creatinine
- High serum bilirubin
- homocysteine [43]
- low body-mass index,

- broad QRS[36]
- , T-wave alternans[37],
- low heart rate variability,
- low 6 min walking ability,
- high left ventricular filling pressure,
- restrictive mitral filling pattern[38],
- impaired right ventricular function,
- high serum uric acid[39,48],
- high plasma interleukin –6[40],
- high plasma oxidised LDL[41],
- low cardiac index, high resting heart rate and high serum norepinephrine[42] portend a bad prognosis in these patients.
- The inherent limitations associated with these factors necessitate the use of more than one factor in prognostication of chronic HF. Predictability and cost efficacy concerns have inculcated further studies in this area.

NEED FOR A PROGNOSTIC BIOMARKER[49]- WHERE ARE WE?

Latest biomarkers include

- ST2
- Galectin-3
- Neuregulin-1
- Copeptin
- pro-adrenomedullin
- ANP/BNP
- sTWEAK

All these investigations are costly and cannot be done everywhere.The quest for a cheap and easily available test has been successful and the results are promising, though with limited research globally. Recently Red Cell Distribution Width (RDW) was found to be elevated in many heart failure cohorts[44].It is considered as a measure of variability in RBC size. It is represented in 2 forms- RDW-CV (coefficient of variation) or RDW-SD (standard deviation). It is an easily available investigation as most of the hematology instruments measure RBC volume and give RDW. An elevated RDW can predict mortality and morbidity in heart failure. Various postulates and theories have been put forth by many researchers for the cause for elevated RDW in the context of heart failure.

RED CELL DISTRIBUTION WIDTH- WHAT IS IT?

In addition to the MCV, MCH, and MCHC, automated counters provide an index of the distribution of red blood cell volumes, termed the red blood cell distribution width (RDW). Counters use two methods to calculate this value. The first is referred to as the RDW-CV. The RDW-CV is the ratio of the width of the red blood cell distribution curve at 1 SD divided by the MCV (normal RDW-CV = 13 Â± 1%). Since it is a ratio, changes in either the width of the curve or the MCV will influence the result. Microcytosis will tend to magnify any change in the RDW-CV simply by reducing the denominator of the ratio. Conversely, macrocytosis will tend to counterbalance the change in the width of the curve and thereby minimize the change in the RDW-CV[2]. A second method of measuring the RDW, the RDW-SD, is independent of the MCV. The RDW-SD is a direct measurement of the red blood cell distribution width taken at the 20% frequency level (normal RDW-SD = 42 Â± 4fL).

Both measurements of the RDW are essentially mathematical representations of anisocytosis (ie, variations in red blood cell size). Increases in the RDW suggest the presence of a mixed population of cells. Double populations, whether microcytic cells mixed with normal cells or macrocytic cells mixed with normal cells, will widen the curve

and increase the RDW. The RDW-SD is more sensitive to the appearance of minor populations of macrocytes or microcytes since it is measured lower on the red cell volume distribution curve . At the same time, it is overly sensitive to the impact of increased numbers of reticulocytes, which, because of their larger MCV, will broaden the base of the distribution curve. The RDW-CV is less sensitive to the appearance of small populations of microcytes, true macrocytes, or reticulocytes, but better reflects the overall change in size distribution seen with well established macrocytic or microcytic anemias .

CONDITIONS WITH ELEVATED RDW LOW MCV

- Iron deficiency anemia
- Thalassemia

CONDITIONS WITH ELEVATED RDW WITH LOW OR INCREASED MCV

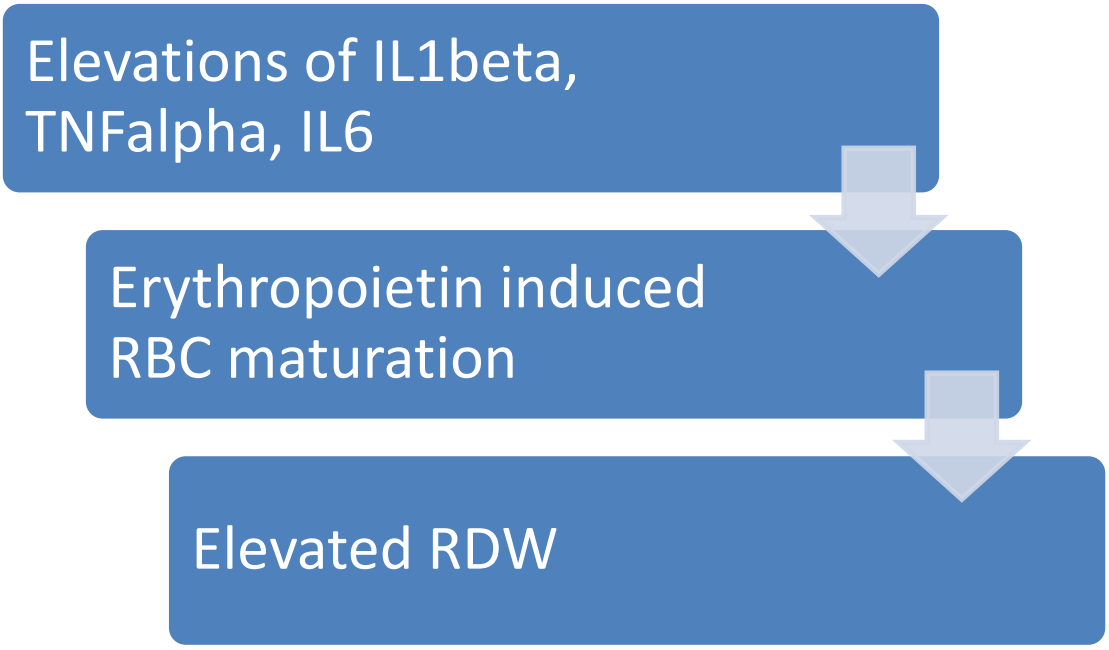
- B12 deficiency
- Folate deficiency
- Recent transfusion

CONDITIONS WITH ELEVATED RDW/ ELEVATED MCV

- Liver disease
- Hemolytic anemia

MECHANISMS FOR ELEVATED RDW IN HEART FAILURE

- Inflammation mediated



- Proinflammatory cytokines
    1. Suppress erythropoietin gene expression[45]
    2. Inhibit proliferation of erythroid progenitor cells
    3. Downregulate erythropoietin receptor expression
    4. Decrease RBC life span
- ANEMIA as cause for elevated RDW
    1. Anemia of chronic disease[46]
    2. Disordered iron metabolism
    3. Renal impairment
    4. Hemodilution
- Bone marrow resistance to erythropoietin

- Oxidative stress induced anisocytosis and decreased RBC survival[47]

Januzzi and coworkers postulated from their research that RDW carries more prognostic information in addition to NT-pro BNP[47] in acute heart failure. Few other studies also demonstrated that RDW is markedly elevated in severe heart failure independent of anemia and is a marker of worst prognosis. Hence RDW is clearly emerging as a new and promising biomarker in heart failure assessment, and candidacy for ventricular assist devices, IABPs, CRTs and transplantation.

Unfortunately there are not many studies comparing RDW with severity of cardiac failure. Here , I have planned to compare the parameter RDW in cases of cardiac failure and analyse RDW with severity of heart failure based on NYHA functional class as well as LV ejection fraction.

MATERIALS AND METHODS

Study centre

Institute of Internal Medicine, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai

Study design

Case control study

Duration of the study

6 months

Sample

100 subjects with clinical evidence of heart failure were selected after applying exclusion criteria. Both inpatients as well as outpatients were selected.100 controls were selected with matching gender and age. Informed consent was obtained from all patients.

Inclusion criteria

- Patients aged between 16 and 80 of both gender
- Known patients of heart failure
- Newly detected patients of heart failure

- Heart failure patients both with preserved as well as reduced EF

Exclusion criteria

- Liver disease
- Renal disease
- Anemia with haemoglobin < 12 g/dl
- Blood transfusion within past 3 months
- Haematological malignancy

Methodology

All cases were subjected to a detailed history taking and clinical examination based on a simple questionnaire which included complaints like dyspnoea, chest pain, orthopnoea, PND, nocturnal cough, syncope, palpitations,etc. All risk factors like smoking, alcoholism, hypertension, diabetes, dyslipidemia, coronary artery disease, heart failure and medications were taken into account. NYHA functional class was applied and patients were classified into 4 classes of heart failure. Clinical features like rales, jugular venous distension,edema,S3 gallop were noted. Body mass index was also calculated for all patients. Fasting and post prandial blood glucose, fasting lipid profile, blood urea, serum creatinine, serum electrolytes, bilirubin, liver enzymes and albumin were measured in all these patients. ECG, XRay chest and 2-D echo were taken for all

these patients. USG abdomen was also done. Based on history, examination and investigation results, complete blood count with Red Cell Distribution Width was done for all the 100 patients who met with the inclusion criteria and compared with 100 controls. Student t test was applied for statistical significance. Patients were followed up and at the end of 1 month, outcome was noted for death or hospitalisations during that period.

12 lead ECG was assessed for

- Ventricular hypertrophy (RVH, LVH)
- Atrial enlargement
- Q waves or ST/T changes denoting ischemia or infarction
- Arrhythmias
- Conduction blocks

XRay chest PA view was noted for

- Pulmonary edema/congestion
- Cardiomegaly
- Effusion

M-mode echocardiography was used to assess left ventricle dimensions. Following parameters were checked.

- LVESD
- LVEDD.
- Ejection fraction (Simpson's method[51]).
- Left ventricle end diastole and Left ventricle end systole volumes are estimated.

Fasting plasma glucose was measured using glucose oxidase and pyruvate oxidase methods from overnight fasting sample and results were read by autoanalyser.2 hr postprandial glucose was measured 2 hrs after routine morning breakfast. From patients height and weight, body mass index (BMI) was calculated. Serum cholesterol (enzymatic oxidase-peroxidase method), Serum HDL (polyethylene glycol-CHOD-PAP method) Triglycerides (enzymatic calorimetric method) were measured using Erba XL 300 autoanalyser. Serum LDL was calculated using Friedewald's formula[52].

Liver function test which included serum bilirubin, transaminases, alkaline phosphatase and albumin was done. Serum creatinine was measured and eGFR was calculated using Cockcroft gault equation. Ultrasonogram of abdomen was done to look for fatty liver or contracted kidneys. Liver disease and renal disease was ruled out.

Blood samples were collected from antecubital vein using 2cc syringe, transferred to an EDTA test tube and analysed in an automated

cell counter Sysmex KX21. Hemoglobin,MCV, Hematocrit and RDW were determined as part of complete blood count. Normal RDW values: RDW-SD—39 to 46 fl

Risk factors were assessed as follows:

Diabetes mellitus[53]

- Blood sugar >126mg/dl after overnight fasting
- Post prandial blood sugar of 200 mg/dl or greater
- Symptoms of DM with random glucose 200 mg/dl or greater
- HbA1C > 6.5%
- patients already diagnosed and on insulin/ OHAs

Systemic hypertension

- systolic BP of 140 mm Hg and above and diastolic BP of 90 mm Hg and above (JNC8)
- known cases on antihypertensives

Obesity [54]

- body mass index > 30 kg/m^2

Dyslipidemia[55]

- Serum total cholesterol >/= 200 mg/dl (Borderline High) or
- Serum HDL </= 40 mg/dl(low) or

- Serum triglycerides >/= 200 mg/dl (High) or
- Serum LDL >/= 160 mg/dl(High) (ATP III guidelines)

Statistical analysis

SPSS software ver.21.0 was used for calculations using the following statistical methods:

- Independent samples ‘t’ test-unpaired
- Independent samples ‘t’ test-paired
- ANOVA
- Pearson correlation coefficient
- Turkey kramer’s multiple comparision test
- Relative risk

Ethical committee clearance

The study was approved by the institutional ethical committee of our hospital

Informed consent

Obtained from all cases and controls

Conflicts of interest

None

OBSERVATIONS AND RESULTS

Table 1: AGE INCIDENCE AMONG CASES AND CONTROLS

Age	Case		Control	
	No	%	No	%
< 20	2	2%	2	2%
20 – 29	5	5%	5	5%
30 – 39	15	15%	15	15%
40 – 49	34	34%	34	34%
50 – 59	26	26%	26	26%
60 – 69	16	16%	16	16%
≥ 70	2	2%	2	2%
Total	100		100	

Among the 100 cases of heart failure selected in our study group, 34% were in the age group of 40 to 49 years, 26% in the age group of 50 to 59 years, 16% in the age group of 60 to 69 and 15% in the age group 30 to 39.

Figure 1: Incidence in age

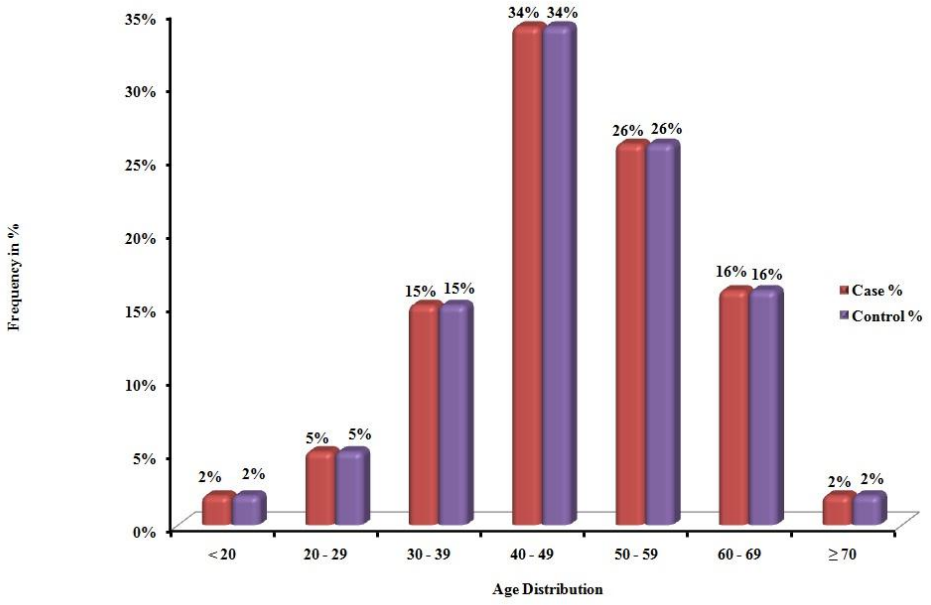
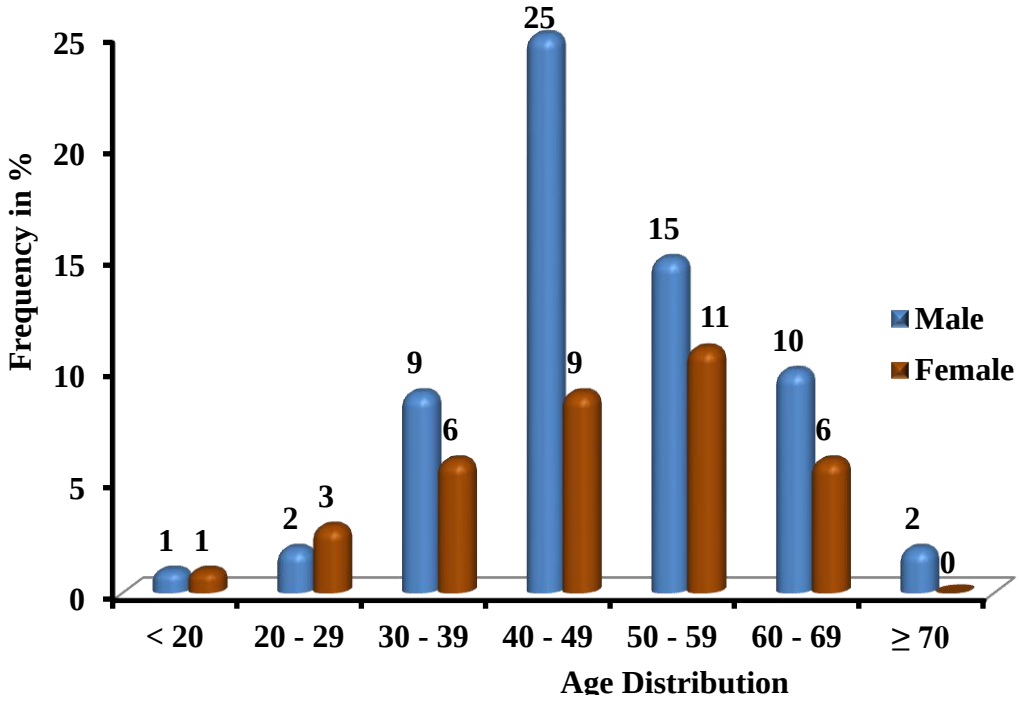


Table 2: AGE AND SEX INCIDENCE AMONG CASES

Age	Gender	Case		Control	
		No	%	No	%
< 20	Male	1	1.0%	1	1.0%
	Female	1	1.0%	1	1.0%
20 - 29	Male	2	2.0%	2	2.0%
	Female	3	3.0%	3	3.0%
30 - 39	Male	9	9.0%	9	9.0%
	Female	6	6.0%	6	6.0%
40 - 49	Male	25	25.0%	25	25.0%
	Female	9	9.0%	9	9.0%
50 - 59	Male	15	15.0%	15	15.0%
	Female	11	11.0%	11	11.0%
60 - 69	Male	10	10.0%	10	10.0%
	Female	6	6.0%	6	6.0%
≥ 70	Male	2	2.0%	2	2.0%
	Female	0	0.0%	0	0.0%
Total		100		100	

Figure 2: incidence of heart failure in male and female among various age groups



In the study group of both cases and controls, 64% were males and 36% were females. **Ratio of male to females was 1.78:1.** In both males and females, the maximum incidence was seen in the age group 40 to 59 years with 40 to 49 the maximum in males and 50 to 59 the maximum in females.

Table3: VARIOUS ETIOLOGY OF HEART FAILURE AND INCIDENCE

Etiology	Male		Female		Total	
	No	%	No	%	No	%
IHD	31	31.0%	16	16.0%	47	47.0%
RHD	6	6.0%	8	8.0%	14	14.0%
Cor pulmonale	8	8.0%	4	4.0%	12	12.0%
DCM idiopathic	7	7.0%	2	2.0%	9	9.0%
Alcoholic Cardiomyopathy	3	3.0%	0	0.0%	3	3.0%
Calcific AS/AR	3	3.0%	1	1.0%	4	4.0%
Peripartum	0	0.0%	2	2.0%	2	2.0%
RVD	3	3.0%	1	1.0%	4	4.0%
Eisenmengers	1	1.0%	1	1.0%	2	2.0%
Myocarditis	2	2.0%	1	1.0%	3	3.0%
Total	64		36		100	

Etiology of heart failure among cases in our study group

- IHD/CAD 47%
- RHD 14%
- COR PULMONALE 12%
- DCM- CAUSE NOT KNOWN 9%
- ALCOHOLIC CARDIOMYOPATHY 3%

- CALCIFIC AS/AR 4%
- PERIPARTUM CARDIOMYOPATHY 2%
- RVD 4%
- EISENMENGER'S 2%
- MYOCARDITIS 3%

Figure CHART REGARDING ETIOLOGY OF HEART FAILURE

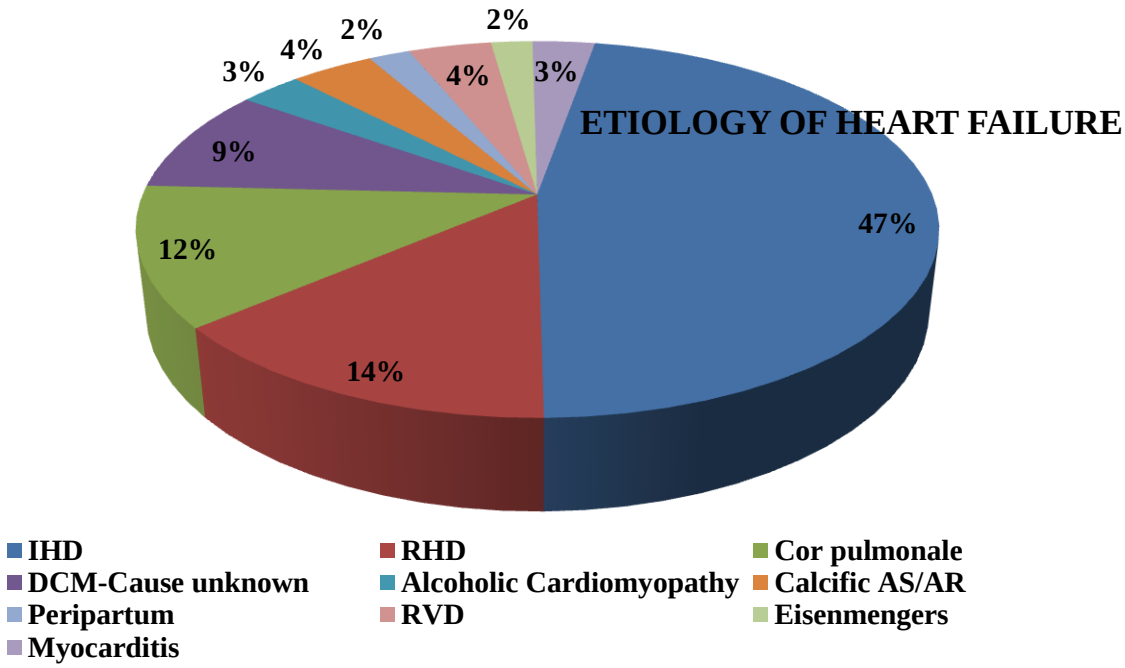


Figure CHART SHOWING ETIOLOGY OF HEART FAILURE IN MALE CASES

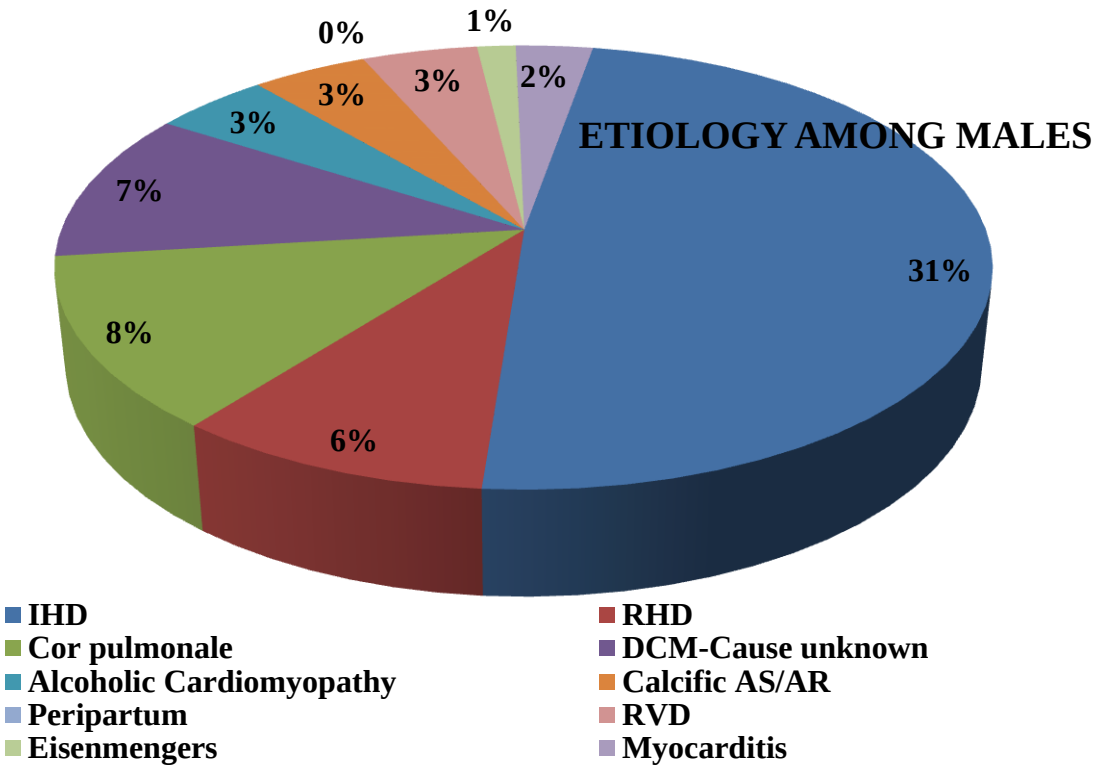


CHART SHOWING ETIOLOGY OF HEART FAILURE AMONG FEMALES

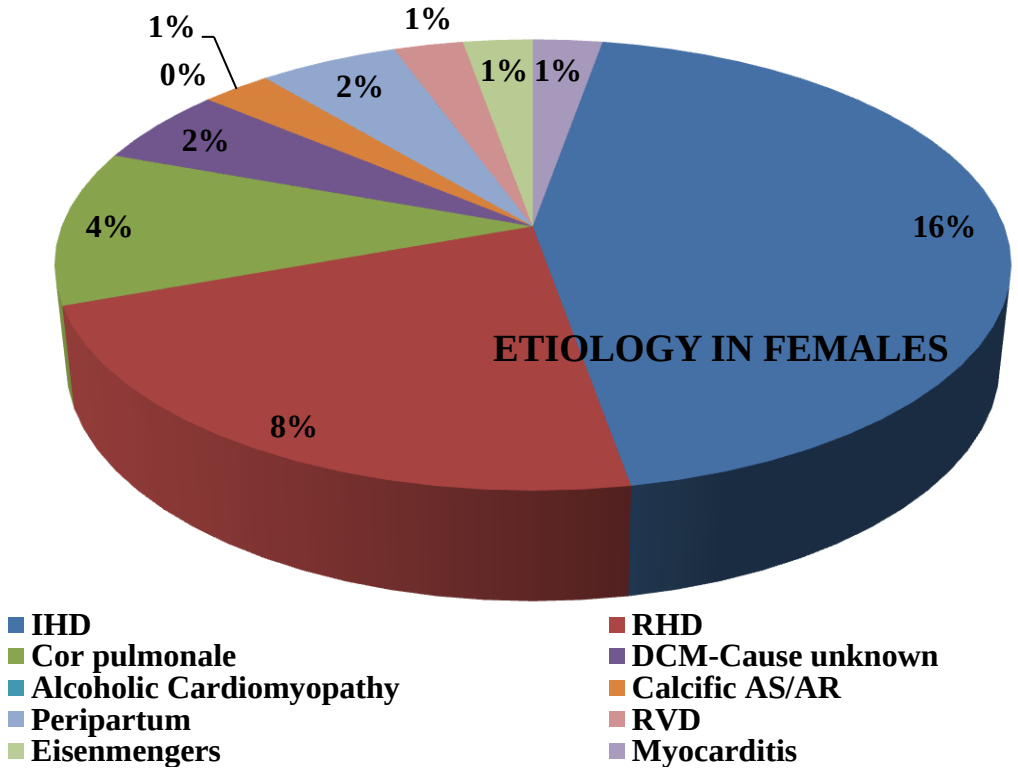


Figure COMPARISION OF THE DISTRIBUTION OF CAUSES OF HEART FAILURE IN MALES AND FEMALES

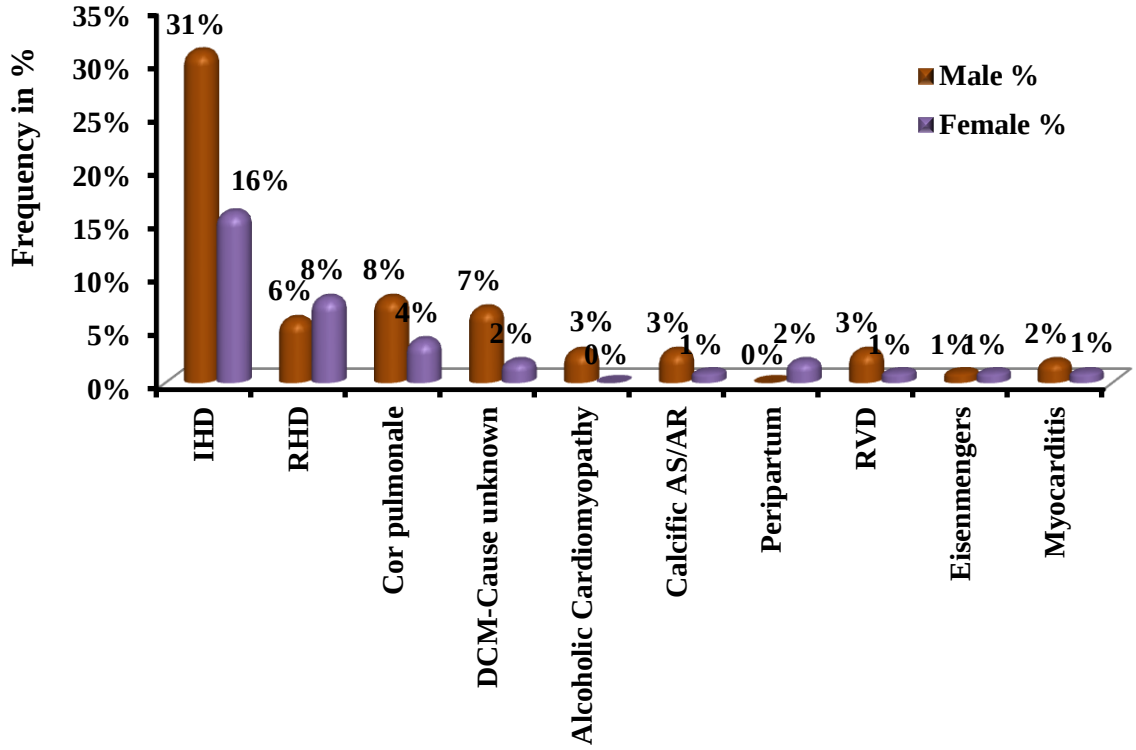


TABLE4: RISK FACTORS IN HEART FAILURE PATIENTS

Risk Factors	Male		Female		Total	
	No	%	No	%	No	%
SHT	28	28.0%	12	12.0%	40	40.0%
DM	23	23.0%	14	14.0%	37	37.0%
Dyslipidemia	20	20.0%	9	9.0%	29	29.0%
Smoking	44	44.0%	0	0.0%	44	44.0%
Alcohol	34	34.0%	0	0.0%	34	34.0%
BMI>30kg/m2	18	18.0%	15	15.0%	33	33.0%
Previous H/o HF	13	13.0%	7	7.0%	20	20.0%
Previous H/o MI	9	9.0%	5	5.0%	14	14.0%

Among the 100 cases studied, incidence of risk factors in percentage

- SHT 40%
- DM 37%
- Dyslipidemia 29%
- Smoking 44%
- Alcohol 34%
- BMI>30kg/m2 33%
- Previous H/o HF 20%
- Previous H/o MI 14%

Figure CHART DEPICTING THE MULTIPLE RISK FACTORS LEADING TO HEART FAILURE

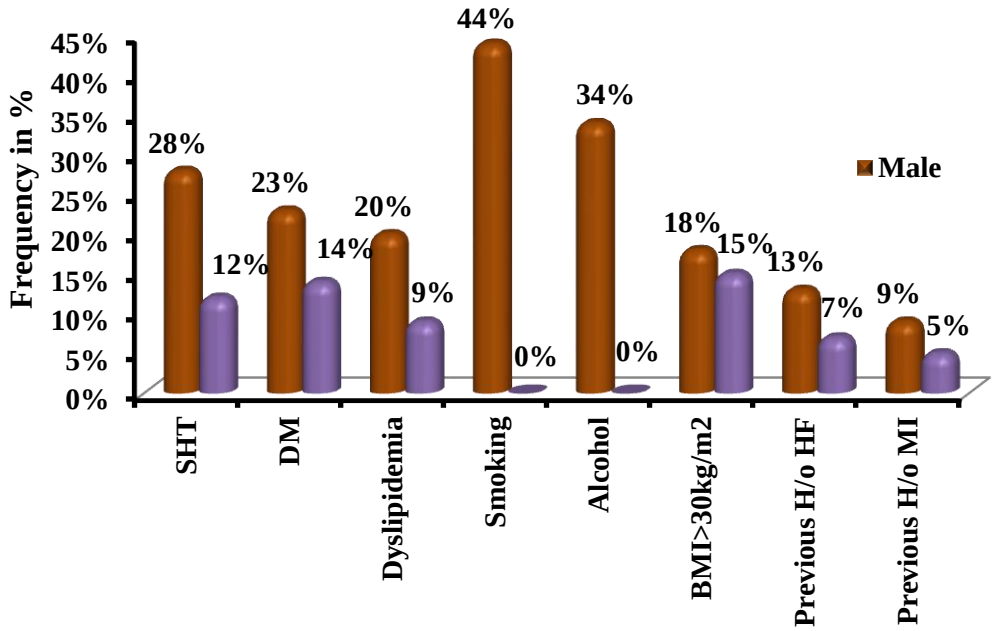


TABLE 5: MAJOR SIGNS AND SYMPTOMS

Signs& Symptoms	Male		Female		Total	
	No	**%**	**No**	**%**	**No**	**%**
PND	20	20.0%	12	12.0%	32	32.0%
Orthopnea	30	30.0%	19	19.0%	49	49.0%
JVD	28	28.0%	13	13.0%	41	41.0%
Rales	21	21.0%	12	12.0%	33	33.0%
S3	17	17.0%	12	12.0%	29	29.0%
Edema	27	27.0%	14	14.0%	41	41.0%

Among 100 cases, the spread up of different clinical signs were like this

- PND 32%
- Orthopnea 49%
- JVD 41%
- Rales 33%
- S3 29%
- Edema 41%

Figure CHART SHOWING MAJOR SIGNS IN MALES AND FEMALES

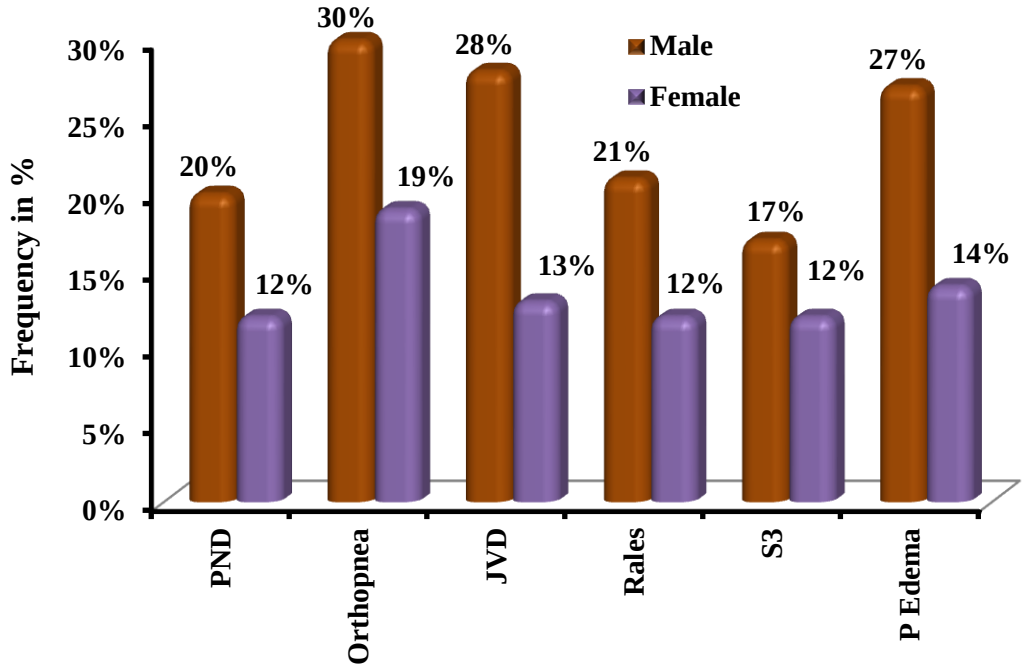


Table 6: RDW LEVELS IN CASES AND CONTROLS:

	Case(n=100)	**Control(n=100)**	**P-Value**
Age	48.25 ± 12.1	48.25 ± 12.1	1 (NS)
RDW-SD	49.9 ± 6.9	42.3 ± 2.3	< 0.01 (S)

RDW-SD was studied in 100 cases and equal number of age and sex matched controls. Their mean values are compared in the table above.

The RDW-SD values were highly significant in heart failure patient study group when compared to controls. ($p<0.01$)

	Case	Control
RDW-SD	49.9	42.3

Figure MEAN RDW LEVELS IN CASES AND CONTROLS

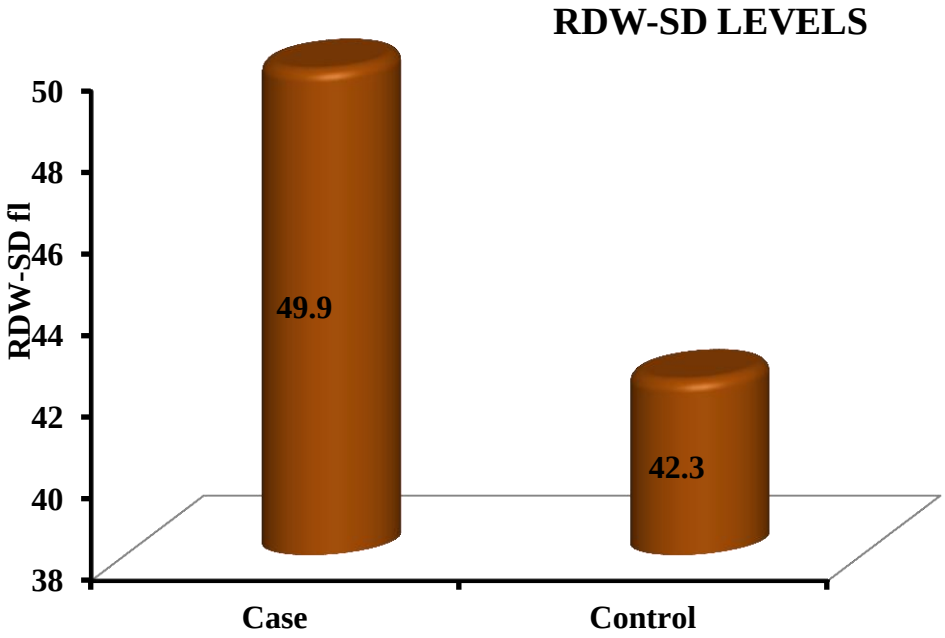


TABLE 7: SHOWING MEAN RDW-SD LEVELS AMONG VARIOUS ETIOLOGY OF HEART FAILURE:

Etiology	Mean RDW
IHD	49.9
RHD	49.9
Cor pulmonale	52.3
DCM-Cause unknown	47.3

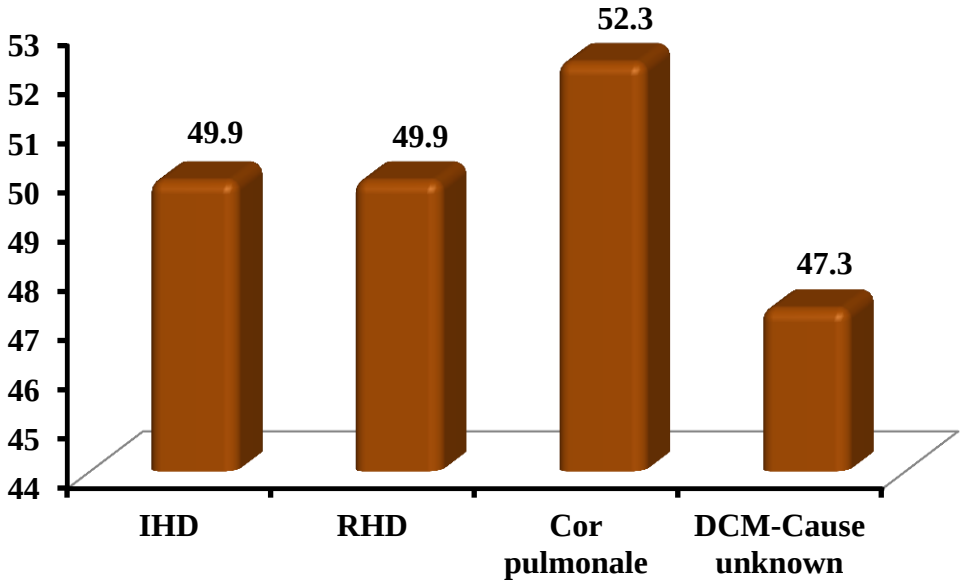


FIGURE : COMPARISION OF RDW LEVELS IN DIFFERENT CAUSES OF HEART FAILURE

RDW-SD levels were compared among different causes of heart failure and was found to be high than controls in all causes. This implies that RDW-SD levels were elevated in heart failure cases irrespective of etiology.

COMPARISION OF RDW LEVELS WITH VARIOUS RISK FACTORS

Then the RDW levels were compared among the different risk factors of heart failure. Significant elevations of RDW were seen in cases with risk factors than in cases without risk factors.

Table 9:COMPARING RDW AMONG RISK FACTORS IN HEART FAILURE:

	Yes	No	**P-Value**
SHT	53.5 ± 7.4	47.3 ± 5.1	< 0.01 (S)
DM	53.8 ± 7.5	47.7 ± 5.6	< 0.01 (S)
Dyslipidemia	56.4 ± 6.3	47.2 ± 5.1	< 0.01 (S)
Smoking	51.5 ± 7.4	48.6 ± 6.2	0.040 (S)
Alcohol	52.1 ± 7.1	48.7 ± 6.5	0.018 (S)
BMI>30kg/m2	56.0 ± 6.5	46.9 ± 4.7	< 0.01 (S)

Among these 100 cases, 10 cases were identified as metabolic syndrome based on ATP III guidelines. The mean RDW value among those 10 patients was 59.6 (significantly high)

TABLE 10 : NYHA FUNCTIONAL CLASS AMONG CASES

NYHA	**Male**		**Female**		**Total**	
	No	**%**	**No**	**%**	**No**	**%**
1	4	4.0%	3	3.0%	7	7.0%
2	10	10.0%	5	5.0%	15	15.0%
3	37	37.0%	23	23.0%	60	60.0%
4	13	13.0%	5	5.0%	18	18.0%
Total	64		36		100	

Among 100 cases,

- NYHA Class 1- 7%
- NYHA Class 2- 15%
- NYHA Class 3- 60%
- NYHA Class 4- 18%

FIGURE : NYHA CLASS AMONG HEART FAILURE CASES:

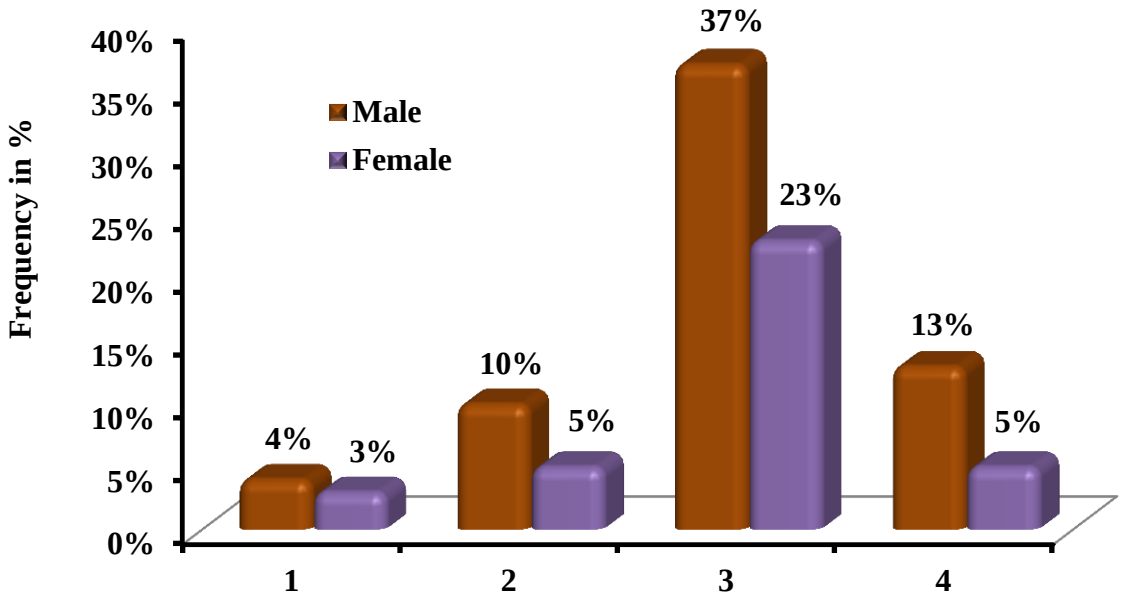


TABLE 11: COMPARISION OF RDW LEVELS AMONG DIFFERENT NYHA CLASS

NYHA	RDW-SD	P-value
1	40.2 ± 1.06	< 0.01 (S)
2	43.6 ± 2.7	
3	49.1 ± 3.2	
4	61.5 ± 4.03	

In patients with NYHA class 1 and 2, mean RDW was within normal range whereas in class 3 and 4, mean RDW was 49.1 and 61.5 respectively. RDW levels were compared among 3 groups ie. NYHA class 2, 3 and 4 using ANOVA test and was found to be statistically very significant. Variation among column means was significantly higher than expected by chance. Cases belonging to NYHA class 4 had higher RDW levels compared to class 3 and 2.

TABLE 12. NYHA CLASS- COMPARISION BETWEEN GROUPS

NYHA	Mean Difference	P-value
Class 2 & Class 4	-5.55	< 0.01 (S)
Class 2 & Class 4	-17.892	< 0.01 (S)
Class 3 & Class 4	-12.342	< 0.01 (S)

By turkey Kramer multiple comparision test, p value is less than 0.01. To find out the correlation between NYHA class and RDW, Pearson's coefficient was used with the following results.

- Correlation coefficient (r) = -0.755
- Coefficient of determination (r^2) =0.570
- P value is less than 0.01 which is quite significant. Hence it was derived that there is correlation between RDW levels and worsening of NYHA functional class.

COMPARISION BETWEEN EJECTION FRACTION AND RDW LEVELS

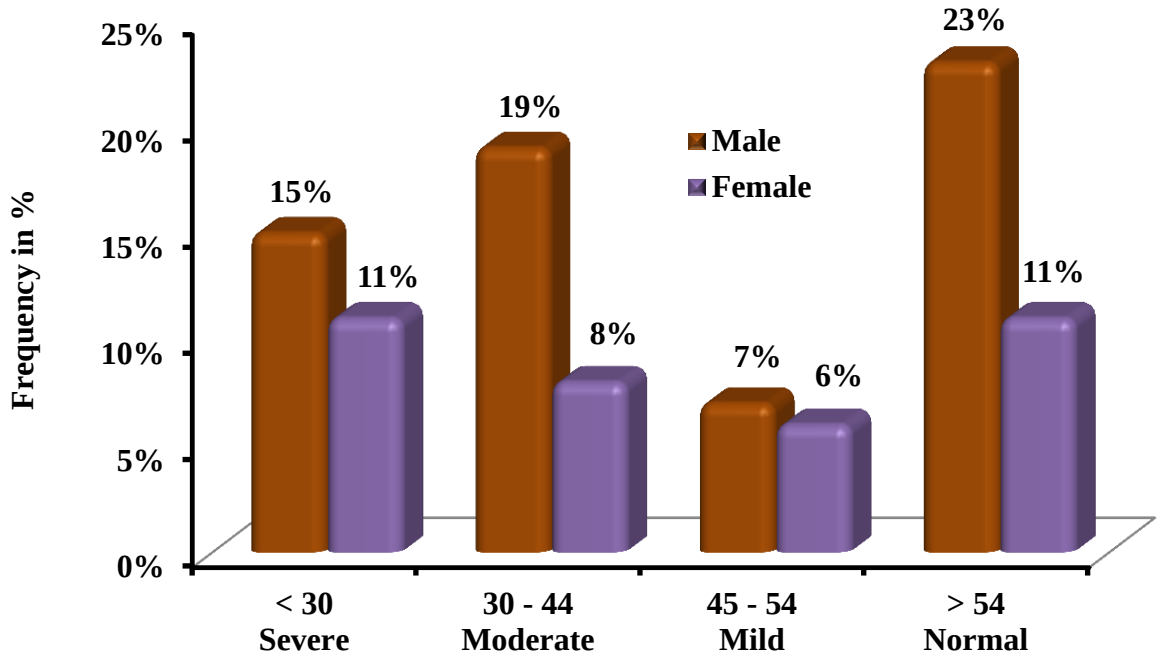
Echo for all heart failure cases was taken and patients were classified into 4 groups on the basis of LV ejection fraction.

- LVEF less than 30% - 26 cases
- LVEF 30 to 44% -27 cases
- LVEF 45 to 54% -13 cases
- LVEF greater than 54% -34 cases

TABLE 13 :SHOWING THE LV EJECTION FRACTION RANGE AMONG CASES:

LVEF%	Male		Female		Total	
	No	%	No	%	No	%
< 30 Severe	15	15.0%	11	11.0%	26	26.0%
30 - 44 Moderate	19	19.0%	8	8.0%	27	27.0%
45 - 54 Mild	7	7.0%	6	6.0%	13	13.0%
> 54 Normal	23	23.0%	11	11.0%	34	34.0%
Total	64		36		100	

FIGURE CLASSIFICATION ON THE BASIS OF LV EJECTION FRACTION



The mean RDW among the 4 different groups based on EF values were compared. Mean RDW was higher in the group with EF < 30% (56.1) when compared with moderate and mild LV dysfunction and was normal in the group where EF> 54%. P value was statistically significant (less than 0.01)

Table 14: COMPARISION OF LV EJECTION FRACTION WITH RDW

LVEF	RDW-SD	P-value
< 30 Severe	56.6 ± 6.1	< 0.01 (S)
30 - 44 Moderate	51.4 ± 4.7	
45 - 54 Mild	50.7 ± 5.4	
> 54 Normal	44 ± 3.1	

Comparisons were made among the 4 groups based on EF using ANOVA test.

TABLE 15: COMPARISION AMONG INDIVIDUAL GROUPS OF LV DYSFUNCTION

LVEF	Mean Difference	P-value
Severe & Moderate	6.44	< 0.01 (S)
Severe & Mild	5.138	0.013 (S)
Severe & Normal	12.628	< 0.01 (S)
Moderate & Mild	-1.302	0.859 (NS)
Moderate & Normal	6.187	< 0.01 (S)
Mild & Normal	7.489	< 0.01 (S)

By turkey Kramer multiple comparision test, p value is less than 0.01 when comparing patients with less than 30% EF with the other groups. To find out the correlation between EF and RDW, Pearson's coefficient was used with the following results.

- Correlation coefficient (r) = 0.640
- Coefficient of determination (r^2) =0.4096

P value is less than 0.01 which is quite significant. Hence it was derived that there is correlation between RDW and LV ejection fraction.

OUTCOME ON FOLLOW UP AT THE END OF ONE MONTH:

Patients were followed up at the end of 1 month. Among the 100 patients, 18 were lost in follow up. In the remaining 82 patients, 11 patients had expired and 13 had been hospitalised for failure symptom exacerbation.

TABLE 15: OUTCOME AT THE END OF 1 MONTH

Outcome after one month	Male		Female		Total	
	No	%	No	%	No	%
Death	11	11%	4	4%	15	15%
Hospitalised	13	13%	12	12%	25	25%
Lost in Followup	13	13%	5	5%	18	18%
Non Hospitalised	27	27%	15	15%	42	42%
Total	64		36		100	

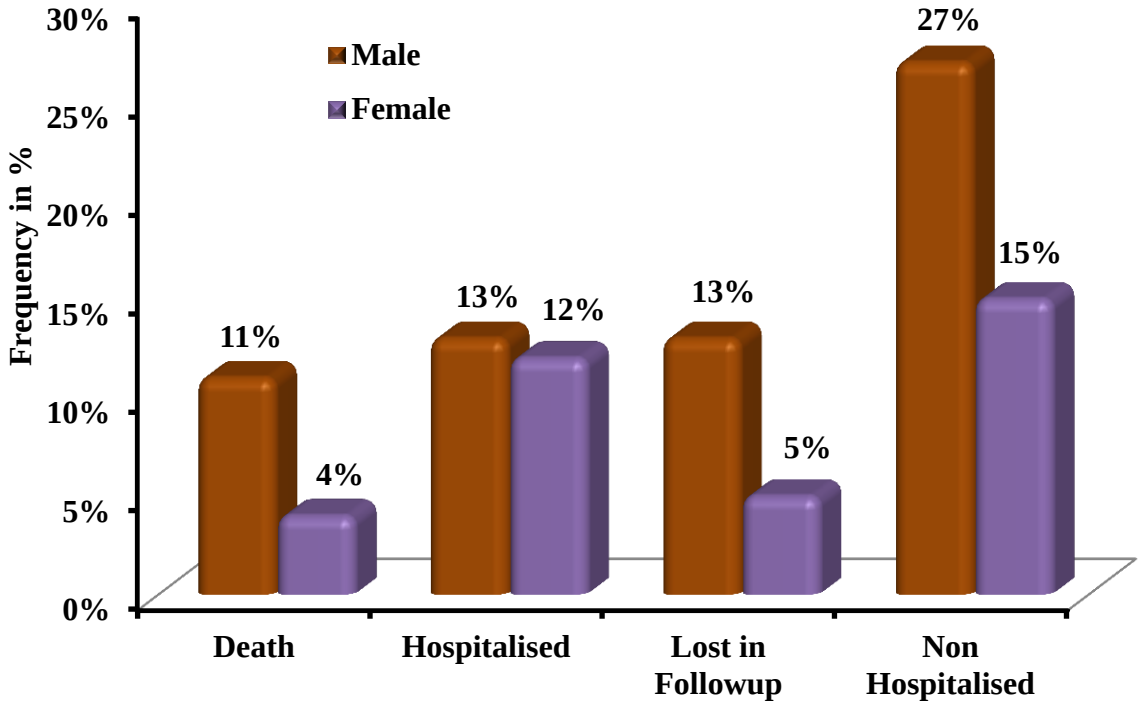


FIGURE SHOWING OUTCOME AT END OF 1 MONTH

The mean RDW of the three categories of patients on the basis of outcome was derived and was found to be significantly higher in patients who died at the end of 1 month ie. 61.3. Mean RDW of those who were hospitalised for symptoms during that 1 month was also higher when compared to those without hospitalisation. P value was very significant(less than 0.01)

Outcome after one month	RDW Mean
Death	61.3
Hospitalised	51.6
Non Hospitalised	46.7

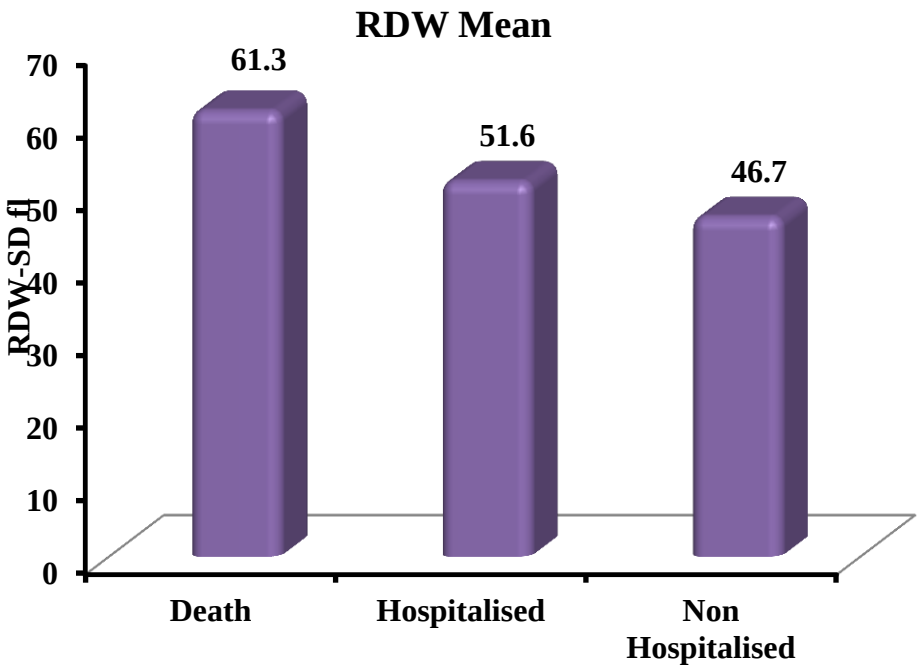
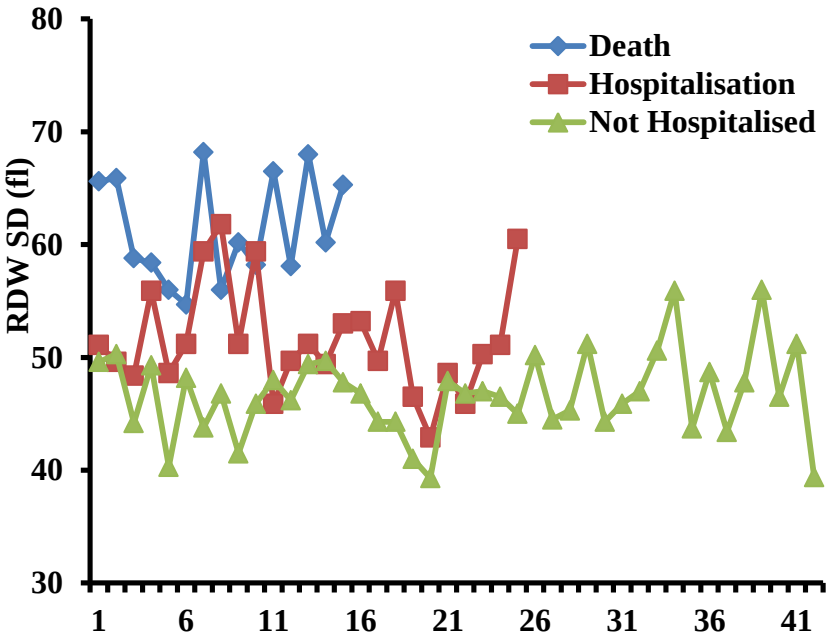


FIGURE SHOWING OUTCOME AT THE END OF 1 MONTH



DISCUSSION

Elevated red cell distribution width has been found to be associated for a long time with increased risk of adverse cardiovascular event in heart failure patients. Although the exact mechanism behind this is not clearly known, several postulates have been contemplated by researchers across the globe. Inflammation and oxidative stress have been considered as the principal reason behind the alteration in erythrocyte homeostasis.

Proinflammatory cytokines[56] like IL-6[40],TNFα and IL-1β erythropoietin mediated RBC maturation leading to increased in RDW. Bone marrow resistance to erythropoietin, deranged iron metabolism, hemodilution and anemia of chronic disease have been proposed as mechanism for anemia[57] and increased mortality in heart failure patients. Although many studies have successfully elucidated the prognostic role of RDW in heart failure, no clear insights into the mechanisms behind the same have been arrived till date. CHARM data and Duke Databank were used to study the role of RDW as a prognostic marker in heart failure[58].

Increased RDW is associated with metabolic syndrome, renal impairment, carotid artery atherosclerosis ,older age and in critically ill patients. Including natriuretic peptides and few other costly markers along with the cheaper RDW has helped in establishing the role of RDW as an independent marker in the prognosis of heart failure.

100 patients with heart failure (inpatients as well as out patients attending our hospital) were selected after exclusion criteria and 100 controls with no comorbidities were also identified . Red Cell Distribution Width was measured in all these people.

The mean age group of patients with heart failure as well as control was 48.25 years with the minimum age of 17 years and maximum of 74 years. 64% were males and 36% were females. **Ratio of male to females was 1.78:1.** In both males and females, the maximum incidence was seen in the age group 40 to 59 years with 40 to 49 the maximum in males and 50 to 59 the maximum in females.

The mean RDW-SD were compared between cases and controls.49.9 in cases and 42.3 in controls. The RDW-SD values were highly significant in heart failure patient study group when compared to controls. ($p<0.01$)

IHD accounted for the major chunk of the cases comprising 47% of cases. The 2nd common cause in our study population was RHD with DCM and cor pulmonale ranking down the order. Mean RDW among various causes ranged between 47.3 in DCM, 49.9 in IHD and RHD and 52.3 in cor pulmonale. This implies that RDW-SD levels were elevated in heart failure cases irrespective of etiology.

RDW was significantly elevated in heartfailure patients with additional risk factors like hypertension, diabetes and dyslipidemia. Mean RDW was 56.4 in patients with dyslipidemia and 56 in patients with BMI >30kg/m^2. Even in controls mean RDW was on the higher side 46.9 in obese individuals. Among 100 cases, 10 cases were identified as metabolic syndrome based on ATP III guidelines. The mean RDW value among those 10 patients was 59.6 (significantly high) .ICARIA (Ibermutuamur Cardiovascular Risk Assessment study) observed that RDW is associated with metabolic syndrome.They stated that a cutoff of 13.5 for RDW-CV in metabolic syndrome.

In patients with NYHA class 1 and 2, mean RDW was within normal range whereas in class 3 and 4, mean RDW was 49.1 and 61.5 respectively. Cases belonging to NYHA class 4 had higher RDW levels compared to class 3 and 2. RDW levels were compared among 3 groups ie. NYHA class 2, 3 and 4 using ANOVA test and was found to be statistically very significant. Pearson's coefficient was used with Correlation coefficient (r) = -0.755 and derived that there is correlation between RDW levels and worsening of NYHA functional class.

Echo revealed 26 persons with EF less than 30%, 27 persons with EF between 30% and 44%, 13 persons with EF between 45% and 54% and 34 persons with EF above 54% .The mean RDW among the 4

different groups based on EF values were compared. Mean RDW was higher in the group with EF < 30% (56.1) when compared with moderate and mild LV dysfunction and was normal in the group where EF> 54%. P value was statistically significant (less than 0.01).correlation coefficient (r) was 0.640. Hence it was concluded that there is correlation between RDW and LV ejection fraction.

Patients were followed up at the end of 1 month. Among the 100 patients, 18 were lost in follow up. In the remaining 82 patients, 11 patients had expired and 13 had been hospitalised for failure symptom exacerbation. The mean RDW of the three categories of patients on the basis of outcome was derived and was found to be significantly higher in patients who died at the end of 1 month ie. 61.3. mean RDW of those who were hospitalised for symptoms during that 1 month was also higher when compared to those without hospitalisation. P value was very significant(less than 0.01).

All our observations revealed that RDW can be used as a cheaper and easily available prognostic marker in heart failure patients. This was in concordance with several studies done in various other centres globally which revealed higher mortality rates with elevated RDW levels.

Kimmenade et al.[59] followed up an acute HF cohort of 205 patients over a period of 12 months for all cause mortality. 31% patients died at

the end of 1 year. Rates of mortality are higher with increased RDW. They suggested that RDW was a significant independent predictor of one year outcome in acute HF.

In another heart failure cohort studied by Felker et al[44], highest RDW quintile (15.5%) had a two fold elevated risk of mortality.

SENIORS study[60] results revealed anemia as an independent marker of death or hospitalisation in elderly chronic heart failure patients.

A study of laboratory parameters and outcomes using Cox proportional hazards model in 2679 HF patients from CHARM program and 2140 HF patients from Duke Databank revealed RDW as a strong and independent predictor of morbidity and mortality.

2 groups of CAD patients, one with RDW>13.8% vs another with RDW<12.6% were studied by Tonelli[61] et al. and was found that death was twice likely in the former group.

In summary, our study found that increased RDW was associated with increased incidence of heart failure. Elevated RDW is a predictor of all cause mortality in HF patients [62]. Though many trials are going on in the management aspect of anemia in HF, only time and further research might reveal if correction of anemia with hematopoietic agents may show

improvement in RDW and in turn in the improvement of the functional class of HF and cause a reduction in mortality.

LIMITATIONS OF THE STUDY

- Small sample size
- Short follow up of only 1 month- a 1 year or 2 year follow up program would have resulted in better assessment of outcome.
- Though anemia in the form of reduced haemoglobin or renal disease leading to anemia were excluded from the study,B12 and folate deficiency anemia were not absolutely ruled out (inspite of normal range of MCV where significant deficiencies can be ruled out safely).

CONCLUSION

- Red Cell Distribution Width(RDW) levels are increased in heart failure patients than in healthy controls
- Heart failure patients with higher NYHA class have elevated RDW levels. Thus RDW levels correlated with NYHA class of HF.
- Heart failure patients with low LV ejection fraction have elevated RDW levels compared with normal LV ejection fraction, thus RDW levels correlated with severity of LV dysfunction.
- RDW can be not just a marker but a strong predictor of mortality in heart failure patients.
- Combining RDW with other biomarkers and NYHA functional class can indeed be a very good predictor of morbidity and mortality.
- Therapy of anemia in heart failure with resultant increase in RDW can aid in a favourable outcome which further requires a lot of prospective studies.

BIBLIOGRAPHY

1. Douglas L.Mann. Harrisons Principles of Internal Medicine 18th edition 1901-1916.
2. Braunwald E. Heart Disease: A Textbook of Cardiovascular Medicine 9th edition. Philadelphia, PA: WB Saunders; 459-650
3. Valentin Fuster, Richard A. Walsh, Robert A. Harrington . Hurst's The Heart, 13th edition
4. Baliga, Ragavendra R.; Eagle, Kim A.Practical Cardiology: Evaluation and Treatment of Common Cardiovascular Disorders, 2nd Edition2008 247-302
5. Michael H.Crawford CURRENT Diagnosis & Treatment: Cardiology, 3rd Edition
6. marshall lichtman ; ernest beutler;Kenneth kaushanky Williams hematology, 7th edition
7. George AL Jr. Inherited disorders of voltage-gated sodium channels. J Clin Invest. 2005;115(8):1990-1999. [PMID: 16075039]
8. Priori SG, Napolitano C. Cardiac and skeletal muscle disorders caused by mutations in the intracellular Ca2+ release channels. J Clin Invest. 2005;115(8):2033-2038. [PMID: 16075044]
9. Meyer M, Schillinger W, Pieske B, et al. Alterations of sarcoplasmic reticulum proteins in failing human dilated cardiomyopathy. Circulation. 1995;92(4):778-784. [PMID: 7641356]
10. Hasenfuss G, Schillinger W, Lehnart SE, et al. Relationship between Na+Ca2+-exchanger protein levels and diastolic function of failing human myocardium. Circulation. 1999;99(5):641-648. [PMID: 9950661]

11. Reiken S, Gaburjakova M, Guatimosim S, et al. Protein kinase A phosphorylation of the cardiac calcium release channel (ryanodine receptor) in normal and failing hearts. J Biol Chem. 2003;278(1):444-453. [PMID: 12401811]
12. Wolff MR, Buck SH, Stoker SW, et al. Myofibrillar calcium sensitivity of isometric tension is increased in human dilated cardiomyopathies: role of altered beta-adrenergically mediated protein phosphorylation. J Clin Invest. 1996;98(1):167-176. [PMID: 8690789]
13. Liao R, Nascimben L, Friedrich J, Gwathmey JK, Ingwall JS. Decreased energy reserve in an animal model of dilated cardiomyopathy. Relationship to contractile performance. Circ Res. 1996;78(5):893-902. [PMID: 8620610]
14. Neubauer S, Horn M, Pabst T, et al. Cardiac high-energy phosphate metabolism in patients with aortic valve disease assessed by 31P-magnetic resonance spectroscopy. J Investig Med. 1997;45(8):453-462. [PMID: 9394098]
15. Scheuer J. Metabolic factors in myocardial failure. Circulation. 1993;87(suppl VII):VII54-VII57.
16. Sakai H, Tsutamoto T, Tsutsui T, et al.Serum level of uric acid, partly secreted from the failing heart, is a prognostic marker in patients with congestive heart failure. Circ J. 2006; 70: 1006–1011.
17. Miller WL, Hartman KA, Burritt MF, et al.Serial biomarker measurements in ambulatory patients with chronic heart failure: the importance of change over time. Circulation. 2007; 116: 249–257.

18. Bettencourt P, Ferreira A, Dias P, et al.Predictors of prognosis in patients with stable mild to moderate heart failure. J Card Fail. 2000; 6: 306–313.
19. Mozaffarian D, Anker SD, Anand I, et al.Prediction of mode of death in heart failure: the Seattle heart failure model. Circulation. 2007; 116: 392–398.
20. Newton GE, Parker JD. Cardiac sympathetic responses to acute vasodilation. Normal ventricular function versus congestive heart failure. Circulation. 1996;94(12):3161-3167. [PMID: 8989124]
21. Brouwer J, van Veldhuisen DJ, Man in 't Veld AJ, et al. Prognostic value of heart rate variability during long-term follow-up in patients with mild to moderate heart failure. The Dutch Ibopamine Multicenter Trial Study Group. J Am Coll Cardiol. 1996;28(5):1183-1189. [PMID: 8890814]
22. Bristow MR, Ginsburg R, Minobe W, et al. Decreased catecholamine sensitivity and beta-adrenergic-receptor density in failing human hearts. N Engl J Med. 1982;307(4):205-211. [PMID: 6283349]
23. Bristow MR, Ginsburg R, Umans V, et al. Beta 1- and beta 2-adrenergic-receptor subpopulations in nonfailing and failing human ventricular myocardium: coupling of both receptor subtypes to muscle contraction and selective beta 1-receptor down-regulation in heart failure. Circ Res. 1986;59(3):297-309. [PMID: 2876788]
24. Vatner DE, Sato N, Galper JB, Vatner SF. Physiological and biochemical evidence for coordinate increases in muscarinic receptors and Gi during pacinginduced heart failure. Circulation. 1996;94(1):102-107. [PMID: 8964109]

25. Iaccarino G, Tomhave ED, Lefkowitz RJ, Koch WJ. Reciprocal in vivo regulation of myocardial G protein-coupled receptor kinase expression by beta-adrenergic receptor stimulation and blockade. Circulation. 1998;98(17):1783-1789. [PMID: 9788834]
26. Gilbert EM, Abraham WT, Olsen S, et al. Comparative hemodynamic, left ventricular functional, and antiadrenergic effects of chronic treatment with metoprolol versus carvedilol in the failing heart. Circulation. 1996;94(11):2817-2825. [PMID: 8941107]
27. API Textbook of Medicine
28. Richards AM, Doughty R, Nicholls MG, et al. Neurohumoral prediction of benefit from carvedilol in ischemic left ventricular dysfunction. Australia-New Zealand Heart Failure Group. Circulation. 1999;99(6):786-792. [PMID: 9989964]
29. Goldman: Cecil Medicine, 23rd edition;2007
30. Drazner MH et al. Prognostic importance of elevated jugular venous pressure and a third heart sound in patients with heart failure. N Engl J Med. 2001 Aug 23;345(8):574–81. [PMID: 11529211]
31. Haywood GA, Rickenbacher PR, Trindade PT, et al. Analysis of deaths in patients awaiting heart transplantation: impact on patient selection criteria. Heart. 1996;75: 455–462.
32. Anker SD, Coats AJS. Metabolic, functional, and haemodynamic staging for CHF? Lancet. 1996; 348: 1530–1531.
33. R C Davis, F D R Hobbs, and G Y H Lip. History and epidemiology. BMJ. 2000 January 1; 320(7226): 39–42
34. Source:NCMH Background Papers—Burden of Disease in India ...2010

35. ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure.2008 Heart Journal (2008) 29,2388–2442, doi:10.1016/j.ejheart.2008.08.005
36. McKee PA, Castelli WP, McNamara PM, Kannel WB. The natural history of congestive heart failure: the Framingham study. N Engl J Med. 1971 Dec 23;285(26):1441-6.
37. Carlson KJ, Lee DC, Goroll AH, Leahy M, Johnson RA (1985). "An analysis of physicians' reasons for prescribing long-term digitalis therapy in outpatients". Journal of chronic diseases 38 (9): 733–9.doi:10.1016/0021-9681(85)90115-8.
38. Harlan WR, oberman A, Grimm R, Rosati RA (1977). "Chronic congestive heart failure in coronary artery disease: clinical criteria".Ann. Intern. Med. 86 (2): 133–8.
39. Killip T, Kimball JT (1967). "Treatment of myocardial infarction in a coronary care unit. A two year experience with 250 patients". Am. J. Cardiol. 20 (4): 457–64.
40. Guidelines for the diagnosis and treatment of chronic heart failure: executive summary (update 2005): The Task Force for the Diagnosis and Treatment of Chronic Heart Failure of the European Society of Cardiology Eur. Heart J., June 1, 2005; 26(11): 1115 - 1140.
41. Cohn JN, Johnson GR,Shabetai R, et al : Ejection fraction, peak exercise oxygen consumption, cardiothoracic ratio, ventricular arrhythmias and serum norepinephrine as determinants of prognosis in heart failure. The V-HeFT VA Co operative StudiesGroup. Circulation 1993; 87: VI-5.
42. Berger R,Stanek B,Frey B , et al :B -type natriuretic peptides (BNP and PRO BNP) predict long term survival in patients with

advanced heart failure treated with atenolol. Journal Of Heart Lung Transplant 2001; 20:251.

43. Iuliano S, Fisher SG, Karasik PE, et al: QRS duration and mortality in patients with congestive heart failure. American Heart Journal 2002; 143:1085-86.

44. Klingenheben T, Zabel M, D'Agostino RB, et al: Predictive value of T wave Alternans for arrhythmic events in patients with congestive heart failure. Lancet 2000; 356: 651-53

45. Hansen A,Haass M,Zugck C, et al: Prognostic value of Doppler echocardiographic mitral inflow patterns: Implications for risk stratification in patients with chronic congestive heart failure. Journal Of American College Of Cardiology 2001; 37: 1049-51

46. Hare JM, Johnson RJ: Uric acid predicts clinical outcomes in heart failure: Insights regarding the role of xanthine oxidase and uric acid in disease pathophysiology. Circulation 2003; 107:1951.

47. Tsutamato T, Hisanaga T, Wada A, et al: Interleukin 6 spill over in the peripheral circulation increases with severity of heart failure and the high plasma Interleukin 6 is an important prognostic predictor in patients with congestive heart failure. Journal Of American College Of Cardiology 1998; 31:391.

48. Tsutsui T, Tsutamato T, Wada A, et al: Plasma oxidized Low density lipoprotein as a prognostic predictor in patients with chronic congestive heart failure Journal Of American College Of Cardiology 2002; 39:957

49. Francis GS, Cohn JN, Johnson G, et al: Plasma norepinephrine, plasma renin activity and congestive heart failure. Relations to survival and the effects of therapy in V-HeFT II .The V-HeFT VA Cooperative Studies Group. Circulation 1993; 87: VI-40

50. May HT, Alharethi R, Anderson JL, Mulhestein JB, et al: Homocysteine Levels Are Associated with Increased Risk of Congestive Heart Failure in Patients with and without Coronary Artery Disease. Cardiology. 2006 Aug; 107(3): 178-184
51. Sugimoto Y, Kinoshita M: Attenuation of compensation of endogenous cardiac natriuretic peptide system in chronic heart failure: Prognostic role of plasma brain natriuretic peptide concentration in patients with chronic symptomatic left ventriculardysfunction.Circulation1997;96:509. European Journal of Heart Failure
52. Rahul Kakkar1 and Richard T. Lee .Directions from Hecate: towards a multi-marker approach for heart failure assessment Eur J Heart Fail (2011) 13 (7): 691-693. doi: 10.1093/eurjhf/hfr059
53. Kenchaiah S, Evans JC, Levy D, et al. Obesity and the risk of heart failure. N Engl J Med. 2002;347(5):305-313. [PMID: 12151467]
54. Shah SJ, Marcus GM, Gerber IL, et al. High-sensitivity C-reactive protein and parameters of left ventricular dysfunction. J Card Fail. 2006;12(1):61-65. [PMID: 16500582]
55. Boston, Little, Brown: The criteria committee of the Newyork Heart association: Nomenclature and criteria for diagnosis of diseases of the heart and great vessels 9 th edition. 1994.
56. Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) Final Report. Circulation, Dec 2002**;** 106**:** 3143**.**
57. Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Diabetes care 26(suppl 1): S5, 2003

58. Ezekowitz JA, McAlister FA, Armstrong PW. Anemia is common in heart failure and is associated with poor outcomes: insights from a cohort of 12 065 patients with new-onset heart failure. Circulation. 2003;107: 223–225.
59. McMurray JJV, Anand IS, Diaz R, Maggioni AP, O'Connor C, Pfeffer MA, Polu KR, Solomon SD, Sun Y, Swedberg K, Tendera M, van Veldhuisen DJ, Wasserman SM, Young JB. Design of the reduction of events with darbepoetin alfa in heart failure (RED-HF): a Phase III, anaemia correction, morbidity-mortality trial. Eur J Heart Fail. 2009;11: 795–801.
60. Felker GM, Allen LA, Pocock SJ, Shaw LK, McMurray JJ, Pfeffer MA,Swedberg K, Wang D, Yusuf S, Michelson EL, Granger CB. Red cell distribution width as a novel prognostic marker in heart failure: data from the CHARM Program and the Duke Databank. J Am Coll Cardiol. 2007;50:40–47.
61. Tonelli M, Sacks F, Arnold M, Moye L, Davis B, Pfeffer M. Relation between red blood cell distribution width and cardiovascular event rate in people with coronary disease. Circulation. 2008;117:163–168.
62. Opasich C, Cazzola M, Scelsi L, De Feo S, Bosimini E, Lagioia R, Febo O, Ferrari R, Fucili A, Moratti R, Tramarin R, Tavazzi L. Blunted erythropoietin production and defective iron supply for erythropoiesis as major causes of anaemia in patients with chronic heart failure. Eur Heart J. 2005;26:2232–2237
63. Masson S, Latini R, Anand IS, Barlera S, Angelici L, Vago T, Tognoni G, Cohn JN,Val-HeFT Investigators. Prognostic value of changes in N-terminal pro-brain natriuretic peptide in Val-HeFT (Valsartan Heart Failure Trial). J Am Coll Cardiol2008;52:997–1003.

64. Pascual-Figal DA, Bonaque JC, Redondo B, Caro C, Manzano-Fernandez S,Sanchez-Mas J, Garrido IP, Valdes M. Red blood cell distribution width predicts long-term outcome regardless of anaemia status in acute heart failure patients.Eur J Heart Fail 2009;11:840–846.
65. Nanas JN, Matsouka C, Karageorgopoulos D, Leonti A, Tsolakis E, Drakos SG,Tsagalou EP, Maroulidis GD, Alexopoulos GP, Kanakakis JE, Anastasiou-Nana MI. Etiology of anemia in patients with advanced heart failure. J Am CollCardiol 2006;48:2485–2489.
66. Silverberg DS, Wexler D, Iaina A. The importance of anemia and its correction in the management of severe congestive heart failure. Eur J Heart Fail 2002;4:681–686.
67. van Kimmenade, Roland RJ, et al. "Red blood cell distribution width and 1-year mortality in acute heart failure." European journal of heart failure 12.2 (2010): 129-136.
68. van Veldhuisen, Dirk J., et al. "Beta-blockade with nebivolol in elderly heart failure patients with impaired and preserved left ventricular ejection fraction: data from SENIORS (Study of Effects of Nebivolol Intervention on Outcomes and Rehospitalization in Seniors With Heart Failure)." Journal of the American College of Cardiology 53.23 (2009): 2150-2158.
69. Hammarsten, Ola, Stefan Jacobsson, and Michael Fu. "Red cell distribution width in chronic heart failure: a new independent marker for prognosis?." European journal of heart failure 12.3 (2010): 213-214.

EVALUATION OF RED CELL DISTRIBUTION WIDTH IN HEART FAILURE PATIENTS : PROFORMA

Name: Age/Sex:

Address: Occupation:

Symptoms:

- Shortness of breath NYHA class
- Orthopnoea
- PND
- Chest pain
- Swelling of legs
- Easy fatiguability
- Palpitations
- Nocturnal cough

Past history:

Diabetes mellitus

Hypertension

Coronary artery disease

Heart failure

Previous hospitalizations for heart failure

Previous CPR

Liver disease

Kidney disease

Tuberculosis

Blood transfusions in the past

Iron/folate/ B12 replacement therapy

Other co morbid illnesses

Personal history:

- Smoking
- Alcoholism

Vitals: PULSE: BLOOD PRESSURE:

General examination:

- Icterus
- Pallor
- Pedal edema
- JVP
- lymphadenopathy

Systemic examination:
CVS:
RS:
ABDOMEN:
CNS:

Investigations:

RFT			**LFT**		
Glucose		mg/dl	Total bilirubin		mg/dl
Urea		mg/dl	Direct bilirubin		mg/dl
Creatinine		mg/dl	SGOT		U/l
Na+		mEq/l	SGPT		U/l
K+		mEq/l	ALP		U/l
			Total protein		g/dl
			Albumin		g/dl

Fasting lipid profile:

Chest X-ray:

ECG:

Echocardiography:

Ultrasound abdomen:

COMPLETE BLOOD COUNT

INVESTIGATIONS		
☐ WBC	$10^3/\mu L$	
☐ RBC	$10^6/\mu L$	
☐ Hemoglobin	gm/Dl	
☐ HCT	%	
☐ MCV	Fl	
☐ MCH	Pg	
☐ MCHC	gm/dL	
☐ Platelet Count	$10^3/\mu L$	
☐ Lymphocyte %	%	
☐ Mixed % (Basophilis, Eosinophils)	%	
☐ Neutrophil %	%	
☐ Lymphocyte #	$10^3/\mu L$	
☐ Mixed #	$10^3/\mu L$	
☐ Neutrophil #	$10^3/\mu L$	
☐ Red cell distribution width	fL	
☐ Platelet distribution width	fL	
☐ Mean Platelet volume	fL	
☐ P- LCR (large platelet ratio)	%	
Peripheral smear		

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI -3

Telephone No : 044 25305301
Fax : 044 25363970

CERTIFICATE OF APPROVAL

To
Dr. S. Barani Velan
PG in MD General Medicine
Madras Medical College, Chennai -3

Dear Dr. S. Barani Velan

The Institutional Ethics committee of Madras Medical College, reviewed and discussed your application for approval of the proposal entitled "Evaluation of red cell distribution width in heart failure patients" No.16062012.

The following members of Ethics Committee were present in the meeting held on 19.06.2012 conducted at Madras Medical College, Chennai -3.

1.	Dr. S.K. Rajan. M.D.,FRCP.,DSc	-- Chairperson
2.	Prof. K. Ramadevi MD Prof of Biochemistry, MMC, Ch-3	-- Member
3.	Prof. R. Nandhini MD Director, Inst. of Pharmacology ,MMC, Ch-3	-- Member
4.	Prof. C. Rajendiran, MD Director , Inst. of Internal Medicine, MMC, Ch-3	-- Member
5.	Prof. S. Deivanayagam MS Prof of Surgery, MMC, Ch-3	-- Member
6.	Prof. A. Radhakrishnan MD Prof of Internal Medicine, MMC, Ch-3	-- Member

We approve the proposal to be conducted in its presented form.

Sd/ Chairman & Other Members

The Institutional Ethics Committee expects to be informed about the progress of the study, and SAE occurring in the course of the study, any changes in the protocol and patients information / informed consent and asks to be provided a copy of the final report.

Member Secretary, Ethics Committee

turnitin

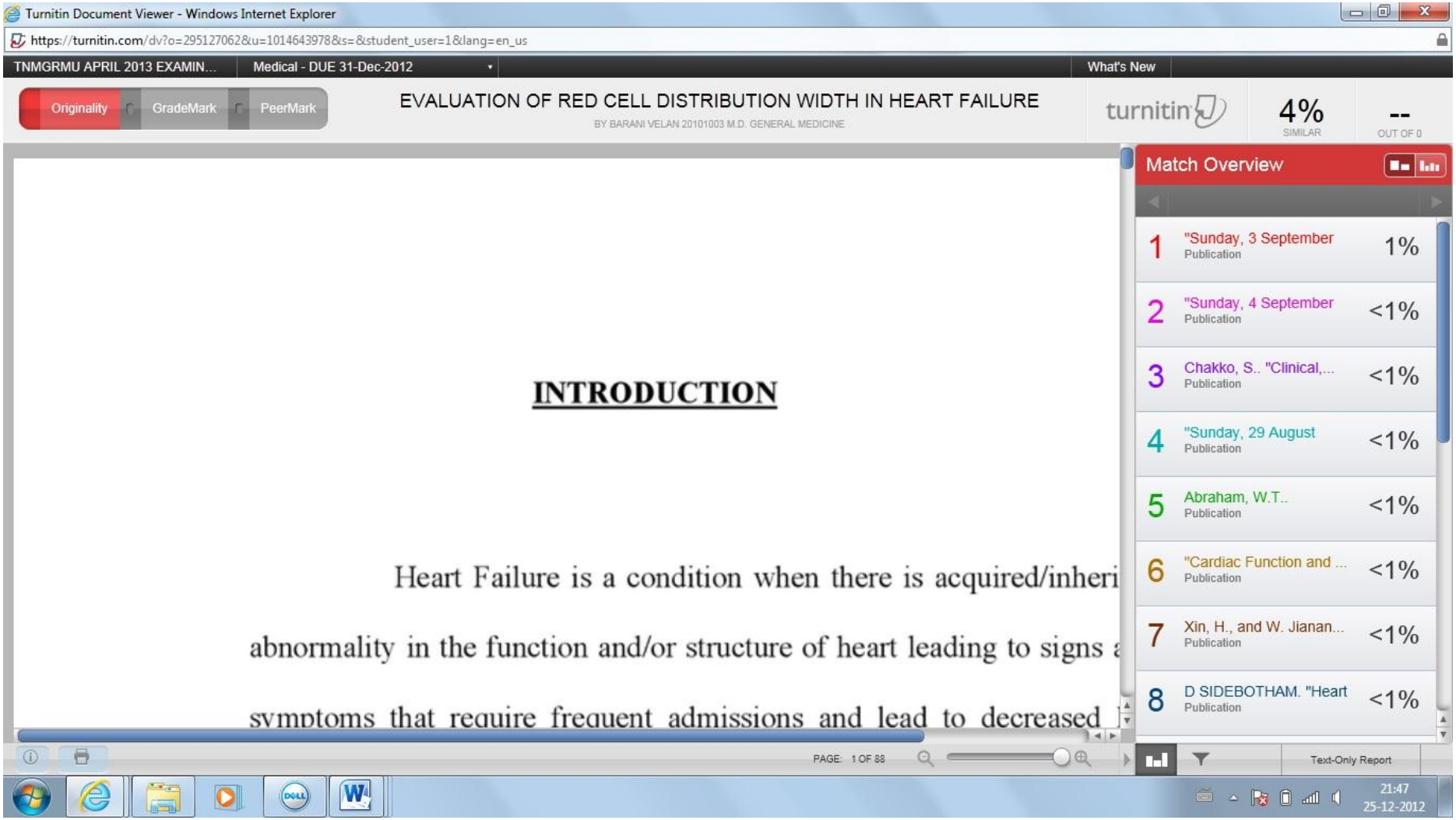
Your digital receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

Paper ID	295127062
Paper title	EVALUATION OF RED CELL DISTRIBUTION WIDTH IN HEART FAILURE PATIENTS
Assignment title	Medical
Author	Barani Velan 20101003 M.D. General Medicine
E-mail	sbvsubham.barney1984@gmail.com
Submission time	25-Dec-2012 09:22PM
Total words	10473

First 100 words of your submission

INTRODUCTION Heart Failure is a condition when there is acquired/inherited abnormality in the function and/or structure of heart leading to signs and symptoms that require frequent admissions and lead to decreased life span and poor quality of life 1 . Ischemia remains the chief etiology for heart failure worldwide. Heart failure is the final common outcome in all pathologies of heart disease. It is associated with a lot of comorbidities and lethality across the globe. Over the last decade, several biomarkers have emerged in heart medicine like uric acid, neurohormones, hsCRP , BNP and many other pro inflammatory cytokines which help in the diagnosis as well as prognosis of heart failure....


Turnitin Document Viewer - Windows Internet Explorer
https://turnitin.com/dv?o=295127062&u=1014643978&s=&student_user=1&lang=en_us
TNMGRMU APRIL 2013 EXAMIN...
Medical - DUE 31-Dec-2012
What's New
Originality
GradeMark
PeerMark
EVALUATION OF RED CELL DISTRIBUTION WIDTH IN HEART FAILURE
BY BARANI VELAN 20101003 M.D. GENERAL MEDICINE
turnitin
4%
SIMILAR
--
OUT OF 0
INTRODUCTION
Heart Failure is a condition when there is acquired/inheri
abnormality in the function and/or structure of heart leading to signs a
symptoms that require frequent admissions and lead to decreased
Match Overview
1 "Sunday, 3 September Publication 1%
2 "Sunday, 4 September Publication <1%
3 Chakko, S.. "Clinical,... Publication <1%
4 "Sunday, 29 August Publication <1%
5 Abraham, W.T.. Publication <1%
6 "Cardiac Function and ... Publication <1%
7 Xin, H., and W. Jianan... Publication <1%
8 D SIDEBOTHAM. "Heart Publication <1%
PAGE: 1 OF 88
Text-Only Report
21:47
25-12-2012

S.NO	Name	Age	Gen	Hb	Hct	MCV	RDW-SD	IHD	RHD	Cor pulmonale	DCM-Cause unknown	Alcoholic Cardiomyopathy	Calcific AS/AR	Peripartum	RVD	Eisenmengers	Myocarditis
1	Dinakaran	69	M	13.2	39.8	86.1	46.3	Y	N	N	N	N	N	N	N	N	N
2	Udhayakumar	66	M	12.3	37.6	84.9	49.6	Y	N	N	N	N	N	N	N	N	N
3	Rajan	66	M	13.2	40.5	98.3	55.5	Y	N	N	N	N	N	N	N	N	N
4	Prabhakaran	63	M	13	44.3	85.5	65.6	Y	N	N	N	N	N	N	N	N	N
5	Murugesan	65	M	14.1	41.1	96.3	51.1	Y	N	N	N	N	N	N	N	N	N
6	Iqbal	60	M	13.4	40.5	84.2	42.4	Y	N	N	N	N	N	N	N	N	N
7	Murugan	50	M	12.3	38.1	90.1	49.6	Y	N	N	N	N	N	N	N	N	N
8	Kumar	54	M	14.1	42	93.2	50.3	Y	N	N	N	N	N	N	N	N	N
9	Johnson	53	M	12.7	37.8	86.7	44.2	Y	N	N	N	N	N	N	N	N	N
10	Ravi	57	M	12.4	42.8	94.7	65.9	Y	N	N	N	N	N	N	N	N	N
11	Gopi	58	M	12.8	37.4	95.4	49.3	Y	N	N	N	N	N	N	N	N	N
12	Vinayagam	59	M	14.2	43.8	88.8	40.3	Y	N	N	N	N	N	N	N	N	N
13	Anthony	52	M	12	37	92.5	48.2	Y	N	N	N	N	N	N	N	N	N

14	Manigandan	28	M	14	44.6	79.6	48.4	Y	N	N	N	N	N	N	N	N	N
15	Ramesh	33	M	12.1	33.8	89.2	44.6	Y	N	N	N	N	N	N	N	N	N
16	Vijay	34	M	16	48	103.9	58.8	Y	N	N	N	N	N	N	N	N	N
17	Venu	40	M	13	40	99	55.9	Y	N	N	N	N	N	N	N	N	N
18	Mohammad faisil	41	M	12	36	91.9	58.4	Y	N	N	N	N	N	N	N	N	N
19	Subramani	45	M	13.5	42	92.9	48.6	Y	N	N	N	N	N	N	N	N	N
20	Prasad	43	M	12.5	37	85.1	50.6	Y	N	N	N	N	N	N	N	N	N
21	Srinivasan	47	M	12.8	44	87.8	43.8	Y	N	N	N	N	N	N	N	N	N
22	Rangaraj	46	M	13.5	41	92.4	51.2	Y	N	N	N	N	N	N	N	N	N
23	Maniappan	43	M	12.4	37	88.2	46.8	Y	N	N	N	N	N	N	N	N	N
24	Ayyanar	44	M	12.6	38	85.1	41.5	Y	N	N	N	N	N	N	N	N	N
25	Albert	49	M	12.6	36.2	85.6	40.6	Y	N	N	N	N	N	N	N	N	N
26	Kondaiah	48	M	13.8	41.4	88.1	45.9	Y	N	N	N	N	N	N	N	N	N
27	Rajamundri	49	M	12.8	40.2	91.4	48	Y	N	N	N	N	N	N	N	N	N
28	Krishnan	47	M	12.2	38	94.5	46.2	Y	N	N	N	N	N	N	N	N	N
29	Tamilselvan	48	M	12.9	39	91.8	56	Y	N	N	N	N	N	N	N	N	N
30	Syed	55	M	12.3	37	86	49.4	Y	N	N	N	N	N	N	N	N	N
31	Manoj	77	M	13.2	39.1	94.8	49.7	Y	N	N	N	N	N	N	N	N	N
32	Ayappan	17	M	12.6	38.1	83.4	42.9	N	Y	N	N	N	N	N	N	N	N
33	Ilayaraja	25	M	13.3	39.3	84.4	45.3	N	Y	N	N	N	N	N	N	N	N
34	Vignesh	34	M	13.5	40.1	91	59.4	N	Y	N	N	N	N	N	N	N	N
35	Devaraj	36	M	15.1	45.1	95.8	47.8	N	Y	N	N	N	N	N	N	N	N
36	Vickram	38	M	15.6	46.5	87.7	48.3	N	Y	N	N	N	N	N	N	N	N

37	Elumalai	40	M	12.4	37.3	81.3	41.8	N	Y	N	N	N	N	N	N	N	N
38	Ellapan	55	M	12.4	37	88.2	46.8	N	N	Y	N	N	N	N	N	N	N
39	Chinnapaiyan	57	M	15.8	48	99	54.7	N	N	Y	N	N	N	N	N	N	N
40	Kaliappan	50	M	14.9	45	98.4	68.2	N	N	Y	N	N	N	N	N	N	N
41	Periyasamy	48	M	13.7	40.5	83.9	44.3	N	N	Y	N	N	N	N	N	N	N
42	Raju	49	M	14.1	41.3	95.9	51.3	N	N	Y	N	N	N	N	N	N	N
43	Anandan	45	M	15.3	45.6	100.9	61.8	N	N	Y	N	N	N	N	N	N	N
44	Nagoormeeran	43	M	12.7	38.1	87.8	51.2	N	N	Y	N	N	N	N	N	N	N
45	Franklin	37	M	13.5	40.1	91	59.4	N	N	Y	N	N	N	N	N	N	N
46	Ganesan	64	M	12.6	38.3	94.5	45.9	N	N	N	Y	N	N	N	N	N	N
47	Sivaraman	60	M	12.2	36.9	83.4	44.3	N	N	N	Y	N	N	N	N	N	N
48	Arumugam	59	M	12.7	37.3	91.8	56	N	N	N	Y	N	N	N	N	N	N
49	Arokkiayasamy	51	M	12.9	38.4	94.8	49.7	N	N	N	Y	N	N	N	N	N	N
50	Rajakumar	40	M	12.5	38.5	91.8	60.2	N	N	N	Y	N	N	N	N	N	N
51	Selvaraj	48	M	12.1	36.7	84.7	41	N	N	N	Y	N	N	N	N	N	N
52	Aravindan	43	M	12.2	34.8	88.3	39.3	N	N	N	Y	N	N	N	N	N	N
53	Munusamy	37	M	15.4	46.1	96.7	47.9	N	N	N	N	Y	N	N	N	N	N
54	Rangasamy	45	M	13.8	41.8	82.3	41.8	N	N	N	N	Y	N	N	N	N	N
55	Suresh	52	M	12.7	38.1	87.8	51.2	N	N	N	N	Y	N	N	N	N	N
56	Kanappan	66	M	12.6	37.7	91.8	58.2	N	N	N	N	N	Y	N	N	N	N
57	Pandian	70	M	12.8	39	84.5	46.8	N	N	N	N	N	Y	N	N	N	N
58	Mani	65	M	13.1	39	98	66.5	N	N	N	N	N	Y	N	N	N	N
59	Kabilan	44	M	13	38.7	86	47	N	N	N	N	N	N	N	Y	N	N

60	Peer Mohammad	40	M	12.1	39	86.7	46.5	N	N	N	N	N	N	N	Y	N	N
61	Saravanan	35	M	12.4	37.2	88.1	45	N	N	N	N	N	N	N	Y	N	N
62	Kamalakannan	33	M	12.7	38.1	87.8	50.2	N	N	N	N	N	N	N	N	Y	N
63	Venketesan	47	M	13.9	42.1	91.5	44.5	N	N	N	N	N	N	N	N	N	Y
64	Nataraj	53	M	12	36.8	82	39.4	N	N	N	N	N	N	N	N	N	Y
65	Shanthi	59	F	13.4	39.3	84.5	45.3	Y	N	N	N	N	N	N	N	N	N
66	Nagammal	63	F	12.7	38.1	87.8	51.2	Y	N	N	N	N	N	N	N	N	N
67	Rani	66	F	12.3	37	86	49.4	Y	N	N	N	N	N	N	N	N	N
68	Devamala	62	F	12.4	37.3	84	58.1	Y	N	N	N	N	N	N	N	N	N
69	Kuppamal	60	F	12.2	36.9	83.4	44.3	Y	N	N	N	N	N	N	N	N	N
70	Kaniammal	67	F	12.1	36.5	92.5	68	Y	N	N	N	N	N	N	N	N	N
71	Anjalai	58	F	12.3	37.4	89.7	53	Y	N	N	N	N	N	N	N	N	N
72	Manjula	59	F	12	36.5	86.9	53.2	Y	N	N	N	N	N	N	N	N	N
73	Shaheeda	53	F	12.9	38.4	94.8	49.7	Y	N	N	N	N	N	N	N	N	N
74	Syndhia	54	F	12.1	36.7	84.7	41	Y	N	N	N	N	N	N	N	N	N
75	Angammal	56	F	12.5	38.5	91.8	60.2	Y	N	N	N	N	N	N	N	N	N
76	Parvathy	55	F	12.6	38.4	94.7	45.9	Y	N	N	N	N	N	N	N	N	N
77	Malleswari	53	F	13	40	99.8	55.9	Y	N	N	N	N	N	N	N	N	N
78	Chandra	46	F	12.6	38.1	86.5	46.5	Y	N	N	N	N	N	N	N	N	N
79	Muniammal	48	F	12.6	38.1	83.7	42.9	Y	N	N	N	N	N	N	N	N	N
80	Parveen Beevi	44	F	12.2	34.8	88.3	39.3	Y	N	N	N	N	N	N	N	N	N
81	Mookammal	45	F	13.3	39	83.6	47	N	Y	N	N	N	N	N	N	N	N
82	Chinammal	43	F	13.1	39.3	97	54	N	Y	N	N	N	N	N	N	N	N

83	Revathy	32	F	13	36.9	87	50.6	N	Y	N	N	N	N	N	N	N	N
84	Kamatchi	38	F	12.8	36.2	87.7	55.9	N	Y	N	N	N	N	N	N	N	N
85	Saroja	34	F	12.6	38.1	83.7	43.7	N	Y	N	N	N	N	N	N	N	N
86	Kanthammal	33	F	12.8	37.1	91.5	48.7	N	Y	N	N	N	N	N	N	N	N
87	Selvi	25	F	15.6	46.7	87.6	48.3	N	Y	N	N	N	N	N	N	N	N
88	Devagi	17	F	12.4	36.7	94.6	65.3	N	Y	N	N	N	N	N	N	N	N
89	Vasantha	48	F	13.2	41.3	87.1	43.4	N	N	Y	N	N	N	N	N	N	N
90	Rajeswari	42	F	12.3	36.1	95.8	47.8	N	N	Y	N	N	N	N	N	N	N
91	Kavitha	47	F	12.9	39	93.1	56	N	N	Y	N	N	N	N	N	N	N
92	Seethammal	53	F	13.5	42.3	93.1	48.6	N	N	Y	N	N	N	N	N	N	N
93	Vijaya	48	F	12.8	40.9	87.8	43.8	N	N	N	Y	N	N	N	N	N	N
94	Fathima	56	F	12.2	38	94.7	45.9	N	N	N	Y	N	N	N	N	N	N
95	Alicia	66	F	12.3	38.3	89.3	50.3	N	N	N	N	N	Y	N	N	N	N
96	Mariammal	27	F	12.1	37.3	87.9	46.5	N	N	N	N	N	N	Y	N	N	N
97	Velvizhi	33	F	12.7	38.1	87.8	51.1	N	N	N	N	N	N	Y	N	N	N
98	Mary	35	F	13.5	41.2	92.4	51.2	N	N	N	N	N	N	N	Y	N	N
99	Umarani	27	F	12.4	39.3	93.7	60.5	N	N	N	N	N	N	N	N	Y	N
100	Raniammal	58	F	12	36.7	82	39.4	N	N	N	N	N	N	N	N	N	Y
101	Sivakumar	69	M	12.3	36.2	84.6	41.8	N	N	N	N	N	N	N	N	N	N
102	Devendran	66	M	12.6	38.3	87	45.1	N	N	N	N	N	N	N	N	N	N
103	Chandran	66	M	12.6	36.1	80.3	36.8	N	N	N	N	N	N	N	N	N	N
104	Vijayan	63	M	12.6	38.8	85.5	42.9	N	N	N	N	N	N	N	N	N	N
105	Baskar	65	M	12.7	39.6	83	41.7	N	N	N	N	N	N	N	N	N	N

106	Diwakar	60	M	12.3	37.5	82	41.5	N	N	N	N	N	N	N	N	N	N
107	Nagaraj	50	M	12.4	37.5	86.4	42.5	N	N	N	N	N	N	N	N	N	N
108	Kuppan	54	M	12.9	40.4	83.8	41.8	N	N	N	N	N	N	N	N	N	N
109	Chinnathambi	53	M	13.8	41.2	81.9	42.2	N	N	N	N	N	N	N	N	N	N
110	Ravanaiah	57	M	12.1	37	83.7	44.4	N	N	N	N	N	N	N	N	N	N
111	Chellapan	58	M	13.3	39	78.5	47	N	N	N	N	N	N	N	N	N	N
112	Pitchaiyah	59	M	12.5	37.3	81.3	41.8	N	N	N	N	N	N	N	N	N	N
113	Velan	52	M	12.7	35.8	85.6	40.6	N	N	N	N	N	N	N	N	N	N
114	Narayanan	28	M	12.6	36.2	77.4	39.7	N	N	N	N	N	N	N	N	N	N
115	Thangaraj	33	M	12.2	34.8	88.3	39.3	N	N	N	N	N	N	N	N	N	N
116	Chelladurai	34	M	12.2	37.8	80.8	41.9	N	N	N	N	N	N	N	N	N	N
117	Ashokan	40	M	12.2	35.4	83.7	45.2	N	N	N	N	N	N	N	N	N	N
118	Ponnusamy	41	M	12.4	37.5	86.4	42.5	N	N	N	N	N	N	N	N	N	N
119	Pitchandi	45	M	12.3	36.5	82.3	42.4	N	N	N	N	N	N	N	N	N	N
120	Zaheer	43	M	12.6	36.2	83.2	40.8	N	N	N	N	N	N	N	N	N	N
121	Aruldasan	47	M	12	36.8	82	39.4	N	N	N	N	N	N	N	N	N	N
122	Kumaravel	46	M	12.9	37.6	86.7	43.5	N	N	N	N	N	N	N	N	N	N
123	Durairaj	43	M	12.6	36.3	83.5	40.9	N	N	N	N	N	N	N	N	N	N
124	Gokulan	44	M	12.2	37.8	80.9	41.3	N	N	N	N	N	N	N	N	N	N
125	Hariharan	49	M	12.7	36.3	87	40.6	N	N	N	N	N	N	N	N	N	N
126	Poongavanan	48	M	13.8	41.4	88.3	45.9	N	N	N	N	N	N	N	N	N	N
127	Shankar	49	M	12.2	34.8	89.1	39.4	N	N	N	N	N	N	N	N	N	N
128	Venkatiah	47	M	12.6	36.7	83.3	39.7	N	N	N	N	N	N	N	N	N	N

129	Samikannu	48	M	13.6	40.6	92.3	43.2	N	N	N	N	N	N	N	N	N	N
130	Francis	55	M	12.7	39.6	87	42.1	N	N	N	N	N	N	N	N	N	N
131	Ganapathy	77	M	12.6	38.3	87.3	45.1	N	N	N	N	N	N	N	N	N	N
132	Narasimhan	17	M	13.3	39	78.5	47	N	N	N	N	N	N	N	N	N	N
133	Damu	25	M	13.9	42.1	91.6	44.5	N	N	N	N	N	N	N	N	N	N
134	Ahmad	34	M	12.3	36.3	84.7	41.8	N	N	N	N	N	N	N	N	N	N
135	Nayagam	36	M	12.6	36.3	83.2	36.7	N	N	N	N	N	N	N	N	N	N
136	Jeyaraj	38	M	12.7	38.8	88.5	42.3	N	N	N	N	N	N	N	N	N	N
137	Deenadayalan	40	M	12.7	39.6	87	40.7	N	N	N	N	N	N	N	N	N	N
138	Sukumar	55	M	15.9	48	82.9	41.3	N	N	N	N	N	N	N	N	N	N
139	Kannaiah	57	M	14	44.6	89.7	48.4	N	N	N	N	N	N	N	N	N	N
140	Palaniappan	50	M	13.8	41.8	82.3	41.8	N	N	N	N	N	N	N	N	N	N
141	Appasamy	48	M	12.7	39.3	84.3	41.2	N	N	N	N	N	N	N	N	N	N
142	Manickam	49	M	12.8	39	87.8	43.8	N	N	N	N	N	N	N	N	N	N
143	Surendar	45	M	12.2	37.3	94.5	45	N	N	N	N	N	N	N	N	N	N
144	Sathyan	43	M	13.5	42	92.3	46	N	N	N	N	N	N	N	N	N	N
145	Umashankar	37	M	12.6	38.1	83.4	42.9	N	N	N	N	N	N	N	N	N	N
146	Vadivel	64	M	12.3	37.3	85.6	43.2	N	N	N	N	N	N	N	N	N	N
147	Ravindran	60	M	12.5	37.6	86	44.3	N	N	N	N	N	N	N	N	N	N
148	Balaji	59	M	13.5	40.1	82.3	40.9	N	N	N	N	N	N	N	N	N	N
149	Kuppaiah	51	M	12.9	38.7	83	42.7	N	N	N	N	N	N	N	N	N	N
150	Dhanasekar	40	M	13.3	41.1	85.6	43.2	N	N	N	N	N	N	N	N	N	N
151	Raman	48	M	12.1	36	86.1	43.1	N	N	N	N	N	N	N	N	N	N

152	Kamalasekar	43	M	12.2	36.9	84.7	41	N	N	N	N	N	N	N	N	N	N
153	Prabhu	37	M	12.6	38.3	88.7	41.5	N	N	N	N	N	N	N	N	N	N
154	Raju	45	M	12.6	37	85.8	44.3	N	N	N	N	N	N	N	N	N	N
155	Napolean	52	M	12.9	38.5	94.8	47	N	N	N	N	N	N	N	N	N	N
156	Nirmal	66	M	12.7	37.3	89.2	44.6	N	N	N	N	N	N	N	N	N	N
157	Sundar	70	M	12.5	37.5	87.1	39.6	N	N	N	N	N	N	N	N	N	N
158	Shakthivel	65	M	13.3	39.7	92.4	43.5	N	N	N	N	N	N	N	N	N	N
159	Rajeev kumar	44	M	12.5	38.4	88.7	41.5	N	N	N	N	N	N	N	N	N	N
160	Samsuddin	40	M	12.1	36.7	84.7	41	N	N	N	N	N	N	N	N	N	N
161	Thanmbaiah	35	M	12.9	38.4	87	43.3	N	N	N	N	N	N	N	N	N	N
162	Jegadeesan	33	M	13.3	39.3	87.7	45.3	N	N	N	N	N	N	N	N	N	N
163	Balasubramani	47	M	12.7	38	87.8	43.2	N	N	N	N	N	N	N	N	N	N
164	Madhivanan	53	M	12.3	36.1	84.6	41.8	N	N	N	N	N	N	N	N	N	N
165	Madhavi	59	F	13.2	37.4	88.8	40.3	N	N	N	N	N	N	N	N	N	N
166	Shaheena	63	F	12.6	38.3	83.7	39.7	N	N	N	N	N	N	N	N	N	N
167	Gnanapriya	66	F	12.6	37.1	84	36.8	N	N	N	N	N	N	N	N	N	N
168	Malliga	62	F	12.9	40.4	83.8	45.1	N	N	N	N	N	N	N	N	N	N
169	Anthoniammal	60	F	12.7	39.6	83.3	41.5	N	N	N	N	N	N	N	N	N	N
170	Saraswathy	67	F	13.8	42.1	91.5	44.5	N	N	N	N	N	N	N	N	N	N
171	Masthan	58	F	12.4	37.5	86.4	42.5	N	N	N	N	N	N	N	N	N	N
172	Muthulaksmi	59	F	13.6	40.2	92.2	43.2	N	N	N	N	N	N	N	N	N	N
173	Indradevi	53	F	13.8	41.7	98.1	41.7	N	N	N	N	N	N	N	N	N	N
174	Mangammal	54	F	12.1	37	82.9	44.4	N	N	N	N	N	N	N	N	N	N

175	Pavithra	56	F	12.2	35.9	83.9	40.7	N	N	N	N	N	N	N	N	N	N
176	Samithai	55	F	12.8	39.4	87	41.5	N	N	N	N	N	N	N	N	N	N
177	Gajalaksmi	53	F	12.4	38.4	84.3	43.2	N	N	N	N	N	N	N	N	N	N
178	Haripriya	46	F	12.2	35.3	83.6	45.2	N	N	N	N	N	N	N	N	N	N
179	Valli	48	F	12.5	38.5	81.3	42.4	N	N	N	N	N	N	N	N	N	N
180	Poongodi	44	F	12.2	34.8	84.3	39.3	N	N	N	N	N	N	N	N	N	N
181	Sadayammal	45	F	12.2	35.4	83.7	45.2	N	N	N	N	N	N	N	N	N	N
182	Pachayammal	43	F	12.6	36.2	87.4	39.7	N	N	N	N	N	N	N	N	N	N
183	Devi	32	F	12.7	35.8	85.6	40.7	N	N	N	N	N	N	N	N	N	N
184	Kasthuri	38	F	13.2	40.2	87.1	43.4	N	N	N	N	N	N	N	N	N	N
185	Thulasi	34	F	12.8	40.1	82.9	45.3	N	N	N	N	N	N	N	N	N	N
186	Shanmugapriya	33	F	12.1	37.1	84.1	42.3	N	N	N	N	N	N	N	N	N	N
187	Chithra	25	F	13.5	41.1	86.3	41.6	N	N	N	N	N	N	N	N	N	N
188	Janani	17	F	12	37	92.5	43.1	N	N	N	N	N	N	N	N	N	N
189	Sureka	48	F	12.6	38.3	87	45.1	N	N	N	N	N	N	N	N	N	N
190	Subammal	42	F	12.7	37.6	86.5	44.2	N	N	N	N	N	N	N	N	N	N
191	Thangammal	47	F	13.4	40.5	86.1	40.3	N	N	N	N	N	N	N	N	N	N
192	Saritha	53	F	12.2	35.8	87.3	39.3	N	N	N	N	N	N	N	N	N	N
193	Rita	48	F	12.8	37.8	84.6	40.6	N	N	N	N	N	N	N	N	N	N
194	Kannagi	56	F	12.9	38.1	87.3	37.9	N	N	N	N	N	N	N	N	N	N
195	Vimala	66	F	13.8	42.1	87.3	41.8	N	N	N	N	N	N	N	N	N	N
196	Padmavathy	27	F	13.8	41.4	82.3	42.2	N	N	N	N	N	N	N	N	N	N
197	Pushpavathy	33	F	13.3	39	87.7	42.2	N	N	N	N	N	N	N	N	N	N

198	Latha	35	F	12.4	38.8	81.5	42.5	N	N	N	N	N	N	N	N	N	N
199	Usha	27	F	12.7	37.4	91.4	41.4	N	N	N	N	N	N	N	N	N	N
200	Esther	58	F	12.6	38.1	83.4	39.1	N	N	N	N	N	N	N	N	N	N

S.NO	Name	Age	Gender	SHT	DM	Dyslipidemia	Smoking	Alcohol	BMI>30kg/m2	Previous H/o HF	Previous H/o MI	NYHA class	PND	Orthopnea	JVD	Rales	S3	P Edema	LVEF%	Outcome
1	Dinakaran	69	M	N	N	N	y	y	N	N	N	3	N	N	N	N	N	N	58	L
2	Udhayakumar	66	M	N	y	N	y	y	N	N	N	3	N	N	N	N	N	y	49	S
3	Rajan	66	M	y	y	N	y	y	y	y	N	3	y	y	y	y	y	y	44	L
4	Prabhakaran	63	M	y	y	y	y	y	y	y	y	4	y	y	y	y	y	y	25	D
5	Murugesan	65	M	N	y	y	N	y	N	N	N	3	N	y	y	N	N	N	30	H
6	Iqbal	60	M	N	N	N	y	N	N	N	N	2	N	N	N	N	N	N	60	L
7	Murugan	50	M	N	y	N	N	N	N	N	N	3	N	N	N	N	N	N	28	H
8	Kumar	54	M	y	N	y	y	y	N	y	y	3	N	y	y	y	N	y	44	S
9	Johnson	53	M	y	N	N	N	N	N	N	N	3	N	N	N	N	N	N	57	S
10	Ravi	57	M	y	N	y	y	y	y	y	N	4	y	y	y	y	y	y	29	D
11	Gopi	58	M	N	N	N	y	N	N	N	N	3	N	N	N	N	N	N	44	S

12	Vinayagam	59	M	N	y	N	y	N	N	N	N	2	N	N	N	N	N	N	56	S
13	Anthony	52	M	y	y	N	N	N	y	y	N	3	N	N	N	N	N	N	48	S
14	Manigandan	28	M	N	N	N	y	y	N	N	N	3	N	y	N	N	N	N	33	H
15	Ramesh	33	M	y	y	N	N	N	N	N	N	3	N	N	N	N	N	N	41	L
16	Vijay	34	M	y	N	y	y	y	y	N	y	4	y	y	y	y	y	y	24	D
17	Venu	40	M	N	y	y	y	N	N	y	y	3	y	y	y	y	y	y	29	H
18	Mohammad faisil	41	M	y	y	y	y	y	y	y	N	4	y	y	y	y	y	y	25	D
19	Subramani	45	M	N	N	N	y	y	N	N	N	3	N	N	N	N	N	N	29	H
20	Prasad	43	M	y	N	y	y	N	N	N	y	3	y	y	y	y	N	y	56	L
21	Srinivasan	47	M	N	y	N	N	y	N	N	N	2	N	N	N	N	N	N	58	S
22	Rangaraj	46	M	N	N	y	y	y	y	N	y	3	y	y	y	y	N	y	22	H
23	Maniappan	43	M	y	N	N	N	y	N	N	N	2	N	N	N	N	N	N	59	S
24	Ayyanar	44	M	y	N	N	y	N	N	N	N	2	N	N	N	N	N	N	56	S
25	Albert	49	M	N	N	N	y	N	N	N	N	2	N	N	N	N	N	N	61	L
26	Kondaiah	48	M	y	N	N	y	y	N	N	y	3	N	N	N	N	N	N	55	S
27	Rajamundri	49	M	N	N	N	y	y	y	N	N	3	N	N	y	N	N	N	33	S
28	Krishnan	47	M	N	N	N	y	y	N	N	N	3	N	N	N	N	N	N	52	S
29	Tamilselvan	48	M	y	y	y	y	N	y	y	y	4	y	y	y	y	y	y	22	D
30	Syed	55	M	y	N	N	y	N	y	N	N	3	N	y	y	N	N	N	39	S
31	Manoj	77	M	y	N	N	N	N	N	N	N	3	N	y	y	N	N	N	42	S
32	Ayappan	17	M	N	N	N	N	N	N	N	N	2	N	N	N	N	N	N	59	L
33	Ilayaraja	25	M	N	N	N	N	N	N	N	N	3	N	N	N	N	N	N	57	L
34	Vignesh	34	M	N	N	y	y	y	y	y	N	4	y	y	y	y	y	y	38	H

35	Devaraj	36	M	N	N	N	N	y	N	N	N	3	N	N	N	N	N	N	38	S
36	Vickram	38	M	N	N	N	y	N	N	N	N	3	N	y	y	N	N	y	43	L
37	Elumalai	40	M	y	N	N	N	N	N	N	N	1	N	N	N	N	N	N	62	L
38	Ellapan	55	M	N	N	N	N	y	N	N	N	3	N	y	N	N	N	N	57	S
39	Chinnapaiyan	57	M	y	y	N	y	N	N	N	N	3	y	y	y	y	y	y	29	D
40	Kaliappan	50	M	y	y	y	y	y	y	y	N	4	y	y	y	y	y	y	33	D
41	Periyasamy	48	M	N	N	N	N	N	N	N	N	2	N	N	N	N	N	N	60	S
42	Raju	49	M	N	y	N	y	y	N	N	N	3	y	y	y	y	y	y	40	L
43	Anandan	45	M	y	N	y	y	y	y	N	y	4	y	y	y	y	y	y	25	H
44	Nagoormeeran	43	M	y	y	N	y	N	N	N	N	2	N	y	N	N	N	y	36	H
45	Franklin	37	M	y	y	y	y	y	y	y	N	4	y	y	y	y	y	y	51	H
46	Ganesan	64	M	y	N	N	y	N	N	N	N	3	N	N	N	N	N	N	35	H
47	Sivaraman	60	M	N	N	N	N	y	N	N	N	3	N	N	y	N	N	N	60	S
48	Arumugam	59	M	y	y	y	y	y	y	N	N	4	y	y	y	y	y	y	27	D
49	Arokkiayasamy	51	M	y	y	N	y	N	y	N	N	3	N	y	y	N	N	y	23	H
50	Rajakumar	40	M	y	y	y	y	y	N	y	N	4	y	y	y	y	y	y	27	D
51	Selvaraj	48	M	N	N	N	N	N	N	N	N	1	N	N	N	N	N	N	60	S
52	Aravindan	43	M	N	N	N	N	N	N	N	N	1	N	N	N	N	N	N	66	S
53	Munusamy	37	M	N	N	N	N	y	N	y	N	3	N	N	N	N	N	y	59	S
54	Rangasamy	45	M	N	N	N	y	y	N	N	N	2	N	N	N	N	N	N	63	L
55	Suresh	52	M	N	y	y	y	y	y	N	N	3	y	y	y	y	N	y	38	H
56	Kanappan	66	M	y	y	y	N	y	N	N	N	4	y	y	y	y	y	y	42	D
57	Pandian	70	M	N	N	N	y	N	N	N	N	3	N	N	N	N	N	N	53	S

58	Mani	65	M	y	y	y	y	N	y	N	N	4	y	y	y	y	y	y	24	D
59	Kabilan	44	M	N	N	N	y	y	N	N	N	3	N	N	N	N	N	N	49	S
60	Peer Mohammad	40	M	N	N	N	y	y	N	N	N	3	N	N	N	N	N	N	61	S
61	Saravanan	35	M	N	N	N	y	y	N	N	N	3	N	N	N	N	N	N	60	S
62	Kamalakannan	33	M	N	N	N	y	N	N	N	N	3	N	y	N	N	N	y	45	S
63	Venketesan	47	M	N	N	y	N	N	N	N	N	3	N	N	N	N	N	N	40	S
64	Nataraj	53	M	N	N	N	y	N	N	N	N	1	N	N	N	N	N	N	62	L
65	Shanthi	59	F	y	N	y	N	N	N	N	N	3	N	N	N	N	N	N	56	S
66	Nagammal	63	F	y	N	y	N	N	y	y	N	3	y	y	y	y	y	y	48	S
67	Rani	66	F	N	y	N	N	N	N	N	N	3	N	N	N	N	N	N	29	H
68	Devamala	62	F	y	y	N	N	N	y	y	y	4	y	y	y	y	y	y	28	D
69	Kuppamal	60	F	N	N	N	N	N	N	N	N	2	N	N	N	N	N	N	62	S
70	Kaniammal	67	F	y	y	N	N	N	y	y	N	4	y	y	y	y	y	y	29	D
71	Anjalai	58	F	N	N	N	N	N	y	N	y	3	y	y	y	y	y	y	28	H
72	Manjula	59	F	y	N	y	N	N	y	N	y	3	y	y	y	y	y	y	26	H
73	Shaheeda	53	F	N	y	y	N	N	N	N	N	3	N	y	N	N	N	y	26	H
74	Syndhia	54	F	N	N	N	N	N	N	N	N	1	N	N	N	N	N	N	65	L
75	Angammal	56	F	y	y	y	N	N	y	y	y	4	y	y	y	y	y	y	27	D
76	Parvathy	55	F	N	N	N	N	N	N	N	N	3	N	N	N	N	N	N	43	S
77	Malleswari	53	F	y	N	y	N	N	y	N	y	3	y	y	y	y	y	N	29	H
78	Chandra	46	F	N	y	N	N	N	y	N	N	3	N	N	N	N	N	N	38	H
79	Muniammal	48	F	y	N	N	N	N	N	N	N	2	N	N	N	N	N	N	33	H
80	Parveen Beevi	44	F	N	N	N	N	N	N	N	N	1	N	N	N	N	N	N	64	L

81	Mookammal	45	F	N	N	N	N	N	N	N	N	3	N	N	N	N	N	N	59	S
82	Chinammal	43	F	N	N	N	N	N	N	N	N	3	y	y	y	y	y	y	50	L
83	Revathy	32	F	N	y	N	N	N	N	N	N	3	N	y	N	N	N	y	57	S
84	Kamatchi	38	F	y	N	N	N	N	y	y	N	3	y	y	y	y	y	y	50	S
85	Saroja	34	F	N	N	N	N	N	N	N	N	2	N	N	N	N	N	N	58	S
86	Kanthammal	33	F	N	N	N	N	N	N	N	N	3	N	N	N	N	N	N	53	S
87	Selvi	25	F	N	N	N	N	N	N	N	N	3	N	N	N	N	N	N	58	L
88	Devagi	17	F	N	y	y	N	N	y	N	N	4	y	y	y	y	y	y	28	D
89	Vasantha	48	F	N	N	N	N	N	N	N	N	2	N	N	N	N	N	N	59	S
90	Rajeswari	42	F	N	N	N	N	N	N	N	N	3	N	N	N	N	N	N	39	S
91	Kavitha	47	F	y	y	y	N	N	y	y	N	3	y	y	y	y	y	y	43	S
92	Seethammal	53	F	N	y	N	N	N	y	N	N	3	N	y	N	N	N	N	28	H
93	Vijaya	48	F	N	y	N	N	N	N	N	N	2	N	N	N	N	N	N	56	L
94	Fathima	56	F	N	N	N	N	N	y	N	N	3	N	N	N	N	N	N	39	H
95	Alicia	66	F	y	y	y	N	N	y	N	N	3	N	y	y	N	N	y	36	H
96	Mariammal	27	F	N	N	N	N	N	N	N	N	3	N	y	N	N	N	N	42	S
97	Velvizhi	33	F	y	N	N	N	N	y	N	N	3	N	y	N	N	N	N	29	H
98	Mary	35	F	N	y	N	N	N	N	N	N	3	N	y	N	N	N	N	48	S
99	Umarani	27	F	N	N	N	N	N	N	y	N	4	y	y	y	y	y	y	50	H
100	Raniammal	58	F	N	y	N	N	N	N	N	N	1	N	N	N	N	N	N	58	S
101	Sivakumar	69	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
102	Devendran	66	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
103	Chandran	66	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

104	Vijayan	63	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
105	Baskar	65	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
106	Diwakar	60	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
107	Nagaraj	50	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
108	Kuppan	54	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
109	Chinnathambi	53	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
110	Ravanaiah	57	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
111	Chellapan	58	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
112	Pitchaiyah	59	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
113	Velan	52	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
114	Narayanan	28	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
115	Thangaraj	33	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
116	Chelladurai	34	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
117	Ashokan	40	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
118	Ponnusamy	41	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
119	Pitchandi	45	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
120	Zaheer	43	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
121	Aruldasan	47	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
122	Kumaravel	46	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
123	Durairaj	43	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
124	Gokulan	44	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
125	Hariharan	49	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
126	Poongavanan	48	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

127	Shankar	49	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
128	Venkatiah	47	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
129	Samikannu	48	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
130	Francis	55	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
131	Ganapathy	77	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
132	Narasimhan	17	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
133	Damu	25	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
134	Ahmad	34	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
135	Nayagam	36	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
136	Jeyaraj	38	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
137	Deenadayalan	40	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
138	Sukumar	55	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
139	Kannaiah	57	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
140	Palaniappan	50	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
141	Appasamy	48	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
142	Manickam	49	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
143	Surendar	45	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
144	Sathyan	43	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
145	Umashankar	37	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
146	Vadivel	64	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
147	Ravindran	60	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
148	Balaji	59	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
149	Kuppaiah	51	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

150	Dhanasekar	40	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
151	Raman	48	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
152	Kamalasekar	43	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
153	Prabhu	37	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
154	Raju	45	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
155	Napolean	52	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
156	Nirmal	66	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
157	Sundar	70	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
158	Shakthivel	65	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
159	Rajeev kumar	44	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
160	Samsuddin	40	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
161	Thanmbaiah	35	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
162	Jegadeesan	33	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
163	Balasubramani	47	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
164	Madhivanan	53	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
165	Madhavi	59	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
166	Shaheena	63	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
167	Gnanapriya	66	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
168	Malliga	62	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
169	Anthoniammal	60	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
170	Saraswathy	67	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
171	Masthan	58	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
172	Muthulaksmi	59	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

173	Indradevi	53	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
174	Mangammal	54	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
175	Pavithra	56	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
176	Samithai	55	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
177	Gajalaksmi	53	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
178	Haripriya	46	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
179	Valli	48	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
180	Poongodi	44	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
181	Sadayammal	45	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
182	Pachayammal	43	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
183	Devi	32	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
184	Kasthuri	38	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
185	Thulasi	34	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
186	Shanmugapriya	33	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
187	Chithra	25	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
188	Janani	17	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
189	Sureka	48	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
190	Subammal	42	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
191	Thangammal	47	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
192	Saritha	53	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
193	Rita	48	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
194	Kannagi	56	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
195	Vimala	66	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

196	Padmavathy	27	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
197	Pushpavathy	33	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
198	Latha	35	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
199	Usha	27	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
200	Esther	58	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N